SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY, 1932.

GENERAL PHYSICS.

1. Three Methods of Studying Capillary Structure as Applied to Wood. A. J. Stamm. *Physics*, 1. *pp.* 116–128, *Aug.*, 1931.—The three characteristic capillary properties measured are, (1) the ratio of the effective capillary cross-section to the effective length, (2) the average effective capillary radius, and (3) the maximum effective capillary radius. Some of the important characteristics of the porous structure of wood are briefly presented. The first property is determined from electrical resistance measurements of strong salt solutions filling the void structure, and from the specific resistance of the salt solution in bulk. The second is determined by combining the results of the preceding measurements with results obtained from hydrostatic flow studies of a continuous water phase extending through the section. Poiseuille's law is used. A differential pressure drop apparatus was devised for these measurements. The third is determined by measuring the gas pressure required to overcome the effect of the surface tension of water in the capillary systems. The fine capillary structures of heartwood and sapwood are very different. H. M. B.

2. Surface Tension of Liquid Metals. Part IV. The Surface Tension of Mercury. L. L. Bircumshaw. *Phil. Mag.* 12. *pp.* 596–602, *Aug.*, 1931.—In continuation of previous work [see Abstract 31 (1929)], the author has determined the surface tension of mercury at temperatures between 20° and − 37·0° C. by the method of maximum bubble pressure, the bubbles being blown with hydrogen. The surface tension apparently passes through a maximum value at about 33° C. When the bubble is held for a time at the end of the tube at a pressure just below that required to detach it, a small decrease in the surface tension is observed, and this fall in value increases considerably at the lower temperatures. J. S. G. T.

3. Thin Films and Their Physical Properties. H. E. Devaux. *J. de Physique et le Radium*, 2. *pp.* 237–271, *Aug.*, 1931.—A lecture, giving an account of the author's work from 1888, with some account of connected investigations by others, regarding the nature and properties of thin, especially monomolecular, films, with the evidence for the polar character of the molecules and atoms composing them, and the connection thereof with cohesion, expansibility, friction, lubrication and capacity of being wetted, and also of these properties as evinced by albumen and similar substances with living organisms. C. A. S.

4. "Weeping" Liquids: "Tears of Strong Wine." M. Loewenthal. *Phil. Mag.* 12. *pp.* 462–472, *Aug.*, 1931.—The phenomenon is due to change of composition of the peripheral portions of the liquid relatively to that of the main bulk. This may be caused by more rapid evaporation of one constituent of a mixture, *e.g.*, of alcohol, from a mixture with water, or of ether from an ethereal solution of salicylic acid, or by addition of another substance to a pure liquid, *e.g.*, of water by the passage of moist air over pure alcohol. The peripheral layer being very thin, such change in composition extends very rapidly to the under (solid-liquid) interface. Further, a mixture active on a glass surface is inactive if that surface is covered with paraffin. It is therefore considered that, apart from the possible effect of change in surface-energy of the liquid-air interface, the effect is largely dependent on the lower solid-liquid interface, and due to a driving force therein which changes with the changing composition of the liquid. C. A. S.

5. Rupture Phenomena of Liquid Drops. T. Tsutsui. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, Nos.* 312–315. *pp.* 109–124, *Aug.*, 1931. *In English.*—The figures made by falling drops striking a horizontal surface were studied, (1) for non-blurring drops by examination when dry, and (2) for easily blurred drops by immediate photography. Mixtures of alcohol or glycerin with water were used, and other liquids used for comparison. Relations were obtained between the volume of the drop (v), the number (n) and length (l) of the protuberances, and the diameter (d) of the figure, in the form $v \propto nd^2l^2$ for a constant distance of fall, while an increasing distance also increases n, d and l. No definite relations with the viscosity and surface tension could be established. The roughness of the surface also affects n, d and l. The number of protuberances is statistically determined by a physical mechanism and is not due to mere chance. Assuming that the thickness of the drop at the critical point is inversely proportional to its rate of fall, the dependence of the diameter upon volume and rate of fall may be explained. R. S. R.

6. Pendulum Movement under Resistance. A. O. Rein. *Tohoku Math. J.* 34. *pp.* 206–213, *Aug.*, 1931. *In German.*—Deduces equations for: (1) the mathematical pendulum under small angles with resistances varying as the velocity and as the square of the velocity; (2) the mathematical pendulum under wide angles with resistance varying as the square of the velocity; (3) the double pendulum (pendulum with two degrees of freedom); (4) pendulum with movable suspension-point in a medium whose resistance is proportional to the square of the velocity. A. D.

7. Damping of a Pendulum by Viscous Media. F. E. Hoare. *Phil. Mag.* 12. *pp.* 396–404, *Aug.*, 1931. *Supplement.*—Equations are obtained for the decay of amplitude of vibration of a sphere immersed in a viscous liquid, in which the resistance is taken as (1) proportional to the velocity, (2) proportional to the square of the velocity, (3) proportional to the velocity and proportional to the square of the velocity and (4) proportional to the velocity to the power 3/2. Curves drawn from experimental results obtained earlier [see Abstract 1712 (1930)] are compared with those obtained theoretically and it is evident that for wide ranges of amplitude, the equations obtained from conditions (3) and (4) represent experimental results with considerable accuracy. H. M. B.

8. Turbulent and Stream-Line Damping of a Pendulum in Viscous Media. G. W. Brindley. *Phil. Mag.* 12. *pp.* 522–534, *Aug.*, 1931.—The motion of a pendulum consisting of a sphere suspended by a very long fine wire in a viscous fluid is theoretically and experimentally examined. Hoare [see Abstract 2716 (1930)] drew attention to the fact that at amplitudes of 1 cm. Stokes' theory is not in accordance with observation. Where stream-line damping occurs, the decay of amplitude is given by $-\frac{da}{dt} = \text{const}\left(\frac{a}{r}\right)$; and for large amplitudes, where turbulent damping occurs, by $-\frac{da}{dt} = \text{const}\left(\frac{a^2}{r^2}\right)$, in which r is the radius of the sphere. Curves show that these laws are obeyed to within a few per cent. H. M. B.

9. Motion of a Sphere through a Viscous Liquid. C. E. Lemin. *Phil. Mag.* 12. *pp.* 589–596, *Aug.*, 1931.—Ladenburg's modification of Stokes' equation for the terminal velocity of a sphere moving through a viscous fluid, in which account is taken both of the ratio of the radii r/R of the sphere and tube and the ratio of the radius of the sphere r to the height h of the tube (the so-called "end-effect"), is investigated experimentally by examining the velocity of fall, in glycerin, of steel ball-bearings of diameter 0·0625 in. in nine tubes of radii 0·280 cm.–4·840 cm. The results indicate that Ladenburg's modification of the equation holds for values of r/R up to 0·06. For values of R less than 1·25 cm. there is a large increase in the calculated value of the viscosity. The coefficient of viscosity of glycerin at 12° C. is found to be 18·5 poises. J. S. G. T.

10. Dynamic Action Caused by Rectilinear Vortex. A. Masotti. *Pont. Accad. Sci., N. Lincei, Atti*, 84. *pp.* 623–631, *June* 21, 1931.—A purely mathematical paper dealing with the reaction produced in a perfect fluid by a rectilinear vortex in presence of a cylindrical wall placed parallel to the vortex. Two cases are considered, *viz.*, that in which the vortex is fixed and that in which it is free, and therefore mobile. It is demonstrated that during the movement of a free vortex the resultant of the reaction produced by the wall is zero, and that the vortex will always move in such a manner that this resultant remains zero. H. F. G.

11. Wave Resistance of an Ellipsoid. T. H. Havelock. *Roy. Soc., Proc.* 132. *pp.* 480–486, *Aug.* 1, 1931.—In a recent paper [see Abstract 2913 (1931)] it was shown how to obtain, to the usual approximation, the wave resistance of a solid of ellipsoidal form submerged at a constant depth below the surface of water and moving horizontally with any orientation of the axes; and explicit calculations were made for prolate and oblate spheroids moving end-on and broadside-on. The present note is a brief study of an ellipsoid with unequal axes, moving in the direction of the longest axis. In the included discussion, attention is directed specially to cases in which the ratios of the axes are similar to the corresponding ratios for a ship. H. H. Ho.

12. Effect of Variation in Density on the Stability of Superposed Streams of Fluid. G. I. Taylor. *Roy. Soc., Proc.* 132. *pp.* 499–524, *Aug.* 1, 1931.—The stability of a fluid in which the density ρ and velocity U vary with height z above a horizontal plane is discussed mathematically for the case in which $\rho = \rho_0 e^{-\beta z}$ and $U = U_0 + \alpha z$. It is shown that if $\alpha^2 < 4g\beta$, then progressive waves can exist in the medium; while if $\alpha^2 > 4g\beta$, no waves either progressive or exponentially unstable can exist. The problem of the stability of motion of two fluids of density ρ_1 and ρ_2 moving with velocities U_1 and U_2 respectively and separated by an intermediate layer of fluid of thickness h of intermediate density ρ_3 in which the velocity varies continuously from U_1 to U_2 is next discussed. Waves in the system are investigated, and the complete set of waves for all possible values of $U_2 - U_1$ is worked out and illustrated by curves for the particular case of two fluids of densities in the ratio 2 : 1. It appears that for any given value of $U_2 - U_1$ there is always a range of wave-lengths in which the flow is unstable, but as the wave-length diminishes the effect of the transition layer is to make the flow stable again for very short waves. When $U_2 - U_1$ is small, the small range of unstable waves centres round the wave which is such that a backward-moving wave at the upper surface, regarded as existing at a discontinuity of density all of which is moving with speed U_2, exactly coincides in velocity with a similar forward-moving wave at the lower discontinuity of density in fluid moving with velocity U_1. In the case of three superposed fluids in which the velocity increases with height at a uniform rate α throughout, it is shown that the motion is stable or unstable according as $\alpha^2/g\beta$ is $<$ or $>$ 2·0 The criterion for stability in the case of four superposed fluids in which the small change of density at each interface is $\beta\rho h$, the two intermediate layers being each of thickness h and the rate of increase of velocity with height being constant and equal to α_1 is $\alpha^2/g\beta < 2{\cdot}11$. The limiting case of a large number of superposed layers of fluid is not identical in regard to stability with that of a fluid of continuously varying density. [See also following Abstract.] J. S. G. T.

13. Stability of Superposed Streams of Fluids of Different Densities. S. Goldstein. *Roy. Soc., Proc.* 132. *pp.* 524–548, *Aug.* 1, 1931.—The stability of superposed streams of fluids of different densities with a finite width of transition layer is investigated mathematically by the method of small oscillations employing a generalisation to heterogeneous fluids of Rayleigh's discussion of the homogeneous case. A steady motion and distribution of density are specified, and viscosity, diffusion and compression are not taken into account. The results are expressed in terms of two non-dimensional variables, *viz.*, α, the value of $2\pi H/\lambda$, where H is the depth of the transition layer or layers and λ is the wave-length of the progressive wave disturbance, and n, equal to $g(\Delta\rho/\bar{\rho}H)/(\Delta u/H)^2$, where $\Delta\rho$ is the difference in density and Δu the difference in velocity between top and bottom layers and $\bar{\rho}$ is the mean density in the transition layer or layers. When the effect of the change in density on the inertia is not neglected, the results depend also on $\Delta\rho/\bar{\rho}$. In the case of one transition layer of constant density equal to the mean density in the top and bottom layers, there is stability if n lies between $\alpha/(1 \pm e^{-\alpha}) - 1$. In the case of a transition layer comprising three parts each of constant density, the centre part being double the thickness of the other two, there are two distinct regions of instability in the n, α plane diagram. In the case of five layers in the transition fluid, there are three regions of instability in the n, α plane. In every case the lowest critical value of n enters for the same value of $2\pi H/\lambda$, *viz.*, about 1·28. The case of continuous distribution of density is discussed, and it is shown that slight heterogeneity would cause instability for all wave-lengths, but the wave-length for maximum instability would probably remain unaltered. The results when the density changes continuously and there is no foundation of steady motion are derived as the limiting form for n infinite. The system is completely stable and there are an infinite number of principal periods of oscillation. These periods vary continuously and remain real and distinct as n decreases from ∞ to just greater than 1/4, λ/H being assumed large. When n is just greater than 1/4, the periods vary continuously and remain real and distinct when the wave-length is varied over all possible values. The motion is stable for $n > 1/4$. When $n = 1/4$, there is one real principal period if $2\pi H/\lambda <$ about $0 \cdot 4$, and none otherwise; when $n < 1/4$, there is, for $2\pi H/\lambda$ small, one real principal period and an infinite number of unstable modes of oscillation. The motion is unstable for all wave-lengths when $n < 1/4$. [See also preceding Abstract.] J. S. G. T.

14. New Hydraulic Principle. M. Golaz. *Comptes Rendus*, 193. *pp.* 336–338, *Aug.* 17, 1931.—In place of the principle of maximum discharge employed by Belanger in the discussion of the overflow of liquids, the author proposes to substitute the principle of maximum power, *viz.*, that the stable form of the overflow is that which under given external conditions is characterised by the development of the maximum power in that section of the overflow where constituent parts of the liquid flow in parallel directions. J. S. G. T.

15. Two-Dimensional Linear Elastic States. E. Kalman. *Phil. Mag.* 12. *pp.* 572–583, *Aug.*, 1931.—A theoretical investigation of the distribution of the vertical normal stress in horizontal sections. In practice a linear distribution is accepted in designs, but this is found to be valid only in two special cases. Various types of dam profile are considered, ending with a general form. H. M. B.

16. Elasticity Tests. G. Colonnetti and G. M. Pugno. *Pont. Accad. Sci., N. Lincei, Atti*, 84. *pp.* 525–530, *June* 21, 1931.—Points out a source of systematic error in the use of testing machines. The elasticity of constructional materials does not work out at the same values when the tests are taken with increasing weights as with decreasing weights. A. D.

17. Two-Dimensional Problems in Elasticity. G. Kolossoff. *Comptes Rendus*, 193. *pp.* 389–391, *Aug.* 31, 1931.—This mathematical paper deals with applications of functions of imaginary or complex variables to two-dimensional elastic problems. Certain holomorphic functions are applied to the problem of the plane circular ring and an annular area. J. P. A.

18. Stresses in a Bent Beam due to a Small Elliptical Hole on the Neutral Axis. B. Sen. *Phil. Mag.* 12. *pp.* 312–319, *Aug.*, 1931. *Supplement.*—This mathematical paper deals with the stresses at and directed along the boundary of an internal crack inside a bent, deep beam, for which the treatment is the same as that for plane stress. In order to pass in the limit to the case of a crack, an elliptical hole is taken, whose axes are in general inclined to the neutral axis, and whose minor axis may be reduced to zero. If the crack lies wholly in the neutral axis, the stress near the boundary vanishes. For all other cases the value of the stress varies from point to point, but is a maximum at the extremities of the crack. J. P. A.

19. Plane Motion of a System of Points. A. Masotti. *Accad. Lincei, Atti,* 14. *pp.* 20–24, *July,* 1931.—Discusses the plane motion of a system of points the centre of velocities of which is stationary. Let there be two points movable along two concentric circles in opposite directions; the centre of velocities is fixed at the centre of the concentric circles; the values of the velocities are inversely as the radii of the two circles; and if the motions be uniform in the respective circles, the centripetal accelerations are inversely as the cubes of the radii. A. D.

20. Problem of Three Bodies. D. Belorizky. *Comptes Rendus,* 193. *pp.* 314–317, *Aug.* 10, 1931.—It is shown that Sundman's series, giving the solution of the problem of three bodies, are very slowly converging for the special case of the equilateral triangle of Lagrange. G. C. McV.

21. Adiabatic Transformations in Vibrating Systems about Configurations of Stable Equilibrium. G. Krall. *Accad. Lincei, Atti,* 13. *pp.* 924–928, *June* 21, 1931.—An expression for the sum of the potential and kinetic energies of a vibrating system is found to contain certain adiabatic invariants. During a certain transformation $\int_0^\tau \mathrm{T}dt$ is shown to be constant, where T is the kinetic energy. Adiabatic invariants are applied to calculate the work done in adiabatically increasing the tension in a stretched string. Other examples of the use of this method are mentioned. H. M. B.

22. Cylinders Oscillating in a Stream of Water. A. Thom. *Phil. Mag.* 12. *pp.* 490–503, *Aug.,* 1931.—A theory is given of the frequency of the eddies formed by a cylinder suspended transversely in a moving fluid, and also of the strength of the impulse given to the cylinder. Measurements are carried out in oil with the lowest value of the Reynolds number R at which eddies exist; a fundamental change is indicated at $R = 30$. For higher values there is fair agreement with earlier experiments and Rayleigh's empirical relation. A second small cylinder is used as a feeler to measure the strength and epoch of the eddies. Results verify the theory. H. M. B.

23. Vibrations of Revolving Shafts. R. C. J. Howland. *Phil. Mag.* 12. *pp.* 297–311, *Aug.,* 1931. *Supplement.*—From the equations of motion for an element of a rotating elastic shaft, relations are obtained between the two sets of natural frequencies (1) when the shaft is rotating with uniform angular velocity ω, and (2) when the shaft has no rotation. These relations are then deduced from the more general assumptions (*a*) that the shaft has determinate modes of vibration when not rotating, and (*b*) that a transverse force acting at any point of this shaft produces at any other point a transverse deflection proportional to this force. A formula for the first whirling speed Ω_1 is found. If the shaft is connected to machines which produce a disturbing force of the same period as that of the shaft resonance may occur when $\omega = \frac{1}{\sqrt{2}}\Omega_1$, as sometimes happens in practice. The effects of internal friction are, primarily, the introduction of an exponential damping factor into the expressions for the natural frequencies, and secondarily, in conjunction with the weight, to produce a small sideways deflection of the bent shaft. According to the theory, the shaft should be unstable for all speeds above Ω_1. This does not agree with observation, and the author traces omissions from the theory which might account for the continued stability. J. P. A.

24. Torsional Oscillations of Iron Wire. A. G. Hill. *Phil. Mag.* 12. *pp.* 566–572, *Aug.*, 1931.—The equation $y^n(x + a) = b$ is investigated for torsional oscillations of specimens of iron wire, (1) when newly drawn, and (2) when the same wires have been subjected during 24 hours to torsional oscillations; y is the extent and x the number of the oscillation, n, a and b are constants. Results show that n varies with the diameter of the wire, and the initial amplitude of the oscillations. Any effect produced by the 24 hours of oscillation is entirely masked by the effect produced by the variation of the initial oscillation. H. M. B.

25. Equilibrium Forms of Homopolar Crystals. I. N. Stranski and R. Kaischew. *Zeits. f. Krist.* 78. *pp.* 373–385, *July* 1, 1931.—From considerations of the work of separation of the lattice particles in homopolar crystals, it is inferred that, in the ideal case, simple forms cannot occur, but combinations must result. The following lattice types are discussed: simple cubic, body-centred cubic, face-centred cubic, hexagonal close-packed, diamond. F. I. G. R.

26. Habit-Variation in Crystals of Potassium Permanganate. H. E. Buckley. *Zeits. f. Krist.* 78. *pp.* 412–421, *July* 1, 1931. *In English.*—The comparatively evenly developed crystals obtained by slow growth change to a more prismatic habit with rapid growth. The ions Cr_2O_7'', S_2O_6'' and ClO_3' (in descending order) increase the (001) planes; SO_4'', CrO_4'' and SeO_4'' (in similar order) the (110) and (100) planes. Possible explanations, based on the structure of the ions, are discussed. [See Abstract 346 (1931).] C. A. S.

27. Mechanical Properties of Rock-Salt Crystals. W. D. Kusnetzow and W. A. Sementzow. *Zeits. f. Krist.* 78. *pp.* 433–444, *July* 1, 1931.—Forty test specimens showed wide differences amongst themselves for stretching-limit, limiting strength and modulus of elasticity. In the case of natural crystals, the stretching-limit and disruptive-resistance are linear functions of the elasticity modulus. A number of other experimental results are discussed. F. I. G. R.

28. Lattice Structure of Simple Sugars. K. Andress and L. Reinhardt. *Zeits. f. Krist.* 78. *pp.* 477–483, *July* 1, 1931.—Results can be summarised as follows (a, b, c are usual parameters, N the number of molecules in the unit cell):—

	a	b	c	Space Group.	N	Density.
Arabinose	6·48	19·30	4·81	V^4	4	1·65
Xylose	9·21	12·48	5·56	V^4	4	1·53
Ramnose-hydrate	7·84	7·84	6·61	C_2^2	2	1·47
Mannose........	7·62	18·18	5·67	V^4	4	1·50
Glucose	10·40	14·89	4·99	V^4	4	1·54
Fructose........	8·06	10·06	9·12	V^4	4	1·59
Sorbose	6·12	18·24	6·43	V^4	4	1·65

F. I. G. R.

29. Stereochemistry of Crystalline Compounds. Part VI. Compounds AB_2: Geometrical Derivation of Structural Types. P. Niggli and E. Brandenberger. *Zeits. f. Krist.* 79. 5–6. *pp.* 379–429, *Aug.*, 1931.—The authors' method of geometrical derivation of the possible types of crystal structure for compounds of the form AB_2 gives results in agreement with those actually observed. This is noticeable particularly with types such as those of rutile, anatase, brookite, quartz and tridymite, which appear highly complex on superficial examination but, according to the geometric derivation, belong to the simplest possible and most highly symmetrical types. [For Part V see Abstract 2569 (1931).]
T. H. P.

30. Crystal Structure of Hexabromobutylene (Diacetylene Hexabromide). W. Eissner and R. Brill. *Zeits. f. Krist.* 79. 5–6. *pp.* 430–436, *Aug.*, 1931.—Hexabromobutylene, m.p. 185°, forms monoclinic-prismatic crystals of the space group C_{2h}^5. The crystallographic parameters vary distinctly from crystal to crystal and have the mean values $a : b : c = 1\cdot57 : 1 : 2\cdot75$, $\beta = 68° 35'$. The mean refractive index is 1·75 and the double refraction is positive. The plane of the optic axes is (010) and the optic axial angle for sodium in air is 75°. The results of the X-ray examination are best interpreted by the choice of another axial system with $a : b : c = 1\cdot81 : 1 : 1\cdot57$, $\beta = 44° 27'$. The dimensions of the unit cell are $a = 11\cdot5$, $b = 6\cdot40$, $c = 10\cdot0$ Å., and the cell contains two molecules with the symmetry C_i. This modification has, therefore, the symmetrical structural formula $CHBr_2 . CBr : CBr . CHBr_2$, that of the isomeride with the lower m.p., 114°, being $CHBr_2 . CBr_2 . CBr : CHBr$. A view of the atomic arrangement in the molecule is shown. T. H. P.

31. Crystal Structure of N_2O_4. L. Vegard. *Zeits. f. Physik*, 71. 5–6. *pp.* 299–300, *Aug.* 29, 1931.—Hendricks [see Abstract 3698 (1931)] has criticised certain conclusions reached by the author in a previous paper [see Abstract 2168 (1931)]. In reply, the author admits a certain ambiguity in the determination of the structure of solid N_2O_4 from X-ray powder photographs, but does not consider that Hendricks' calculations allow a decision between the alternative groupings T^5 and T^3 to be made. The T^5 grouping is in agreement with the observed intensity distribution in the X-ray diagrams, and until this is also shown to be the case for the T^3 grouping the T^5 space-lattice must be considered to be the correct one.
J. E. K.

32. Condensation on Crystals. M. Volmer and W. Schultze. *Zeits. f. phys. Chem.* 156. *Abt. A.* 1. *pp.* 1–22, *Aug.*, 1931.—The theory of two-dimensional nucleus formation, which requires that with decrease of supersaturation of the vapour the rate of growth shall fall to zero prior to the attainment of equilibrium, has been examined by measurement of the rate of growth of crystals of iodine, naphthalene, and phosphorus in atmospheres of their pure vapours. The results obtained with iodine afford qualitative support to the theory, but with naphthalene complications arise from the orientated deposition of the crystals on the walls of the vessel; owing to the migration of the crystals, prior to orientation, the rate of growth of the crystalline surfaces is dependent on the frequency of formation of nuclei on the (001) faces. The results with phosphorus also may be interpreted in terms of the adsorbed layer of non-oriented molecules. H. F. G.

33. Theory of Crystal Growth. H. Brandes and M. Volmer. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 466–470, *Aug.*, 1931.—The theory developed by Brandes [see Abstract 2446 (1927)] leads to the conclusion that the formation of two-dimensional nuclei on the (001) face of a sodium chloride crystal takes place preferably at the edges and, more especially, at the angles. The same conclusion was drawn by Stranski [see Abstract 40 (1929)] and Kossel mainly from the assumption that deposition of separate atoms or ions will occur under more favourable electrostatic conditions at the edges than on the inside part of the face. According to the authors' views, the differences in this respect are too slight to be a determining factor. T. H. P.

34. Comparison Standards for the Powder Spectrum Method: NiO and CdO. C. J. Ksanda. *Am. J. Sci.* 22. *pp.* 131–138, *Aug.*, 1931.—With Mo radiation and improved technique, the length of the unit cell (cubic) of the two compounds NiO and CdO has been determined afresh with the following results:—

NiO. $a = 4{\cdot}171 \pm 0{\cdot}003$ Å. Density 6·8. Refractive Index (Li) 2·37.
CdO. $a = 4{\cdot}689 \pm 0{\cdot}003$ Å. Density 8·2. Refractive Index (Li) $2{\cdot}4_9$.

The index of refraction is the outcome of microscopical (immersion) observations. F. I. G. R.

35. Physics of Real Crystals. A. Smekal. *Phys. Zeits.* 32. *pp.* 581–583, *Aug.* 1, 1931. *Paper read before the Deut. Phys. Gesell., Jena, May and June*, 1931.—Reviews especially researches dealing with the difference of properties between the ideal lattice, and crystals actually used. Evidence of chemical, mechanical, electrical, photoelectric and ultramicroscopic properties points to a marked divergence between crystals " free of perturbations " (low-temperature formation) and those from high-temperature melts. The vectorial nature of cohesion is discussed, together with the question of incipient plasticity. F. I. G. R.

36. Architecture of the Solid State. W. L. Bragg. *I.E.E., J.* 69. *pp.* 1239–1244, *Oct.*, 1931. *Kelvin Lecture. Nature*, 128. *pp.* 210–212, *Aug.* 8, *and pp.* 248–250, *Aug.* 15, 1931.—The relations between the three classes of solids—metallic (positive ions held together by undistributed shared electrons), organic (associations of negative atoms) and inorganic (associations of negative and positive atoms), and metallic, non-polar and polar bonds respectively are clearly shown, and the nature of the electron distribution in each brought out. The electrostatic basis of the interatomic forces in the inorganic class, consisting of a number of ions, is illustrated by a detailed account of the structure of beryl. The effect of heat, by increasing the vibration of the atom, on the electron distribution is considered, and the slowness of thermal conduction shown to be due to scattering of the waves of which the heat motion consists. Lastly, the difference between theoretical and actual tensile strength of crystals is explained as due to cracks and consequent concentration of stress, and the " mosaic " character of crystals. In the case of rock-salt the actual strength is 1/500 of theoretical. C. A. S.

37. Splitting and Multiplicity of Terms in Solids. H. Ludloff. *Phys. Zeits.* 32. *p.* 583, *Aug.* 1, 1931. *Paper read before the Deut. Phys. Gesell., Jena, May and June*, 1931.—The evaluation of entropy and ferromagnetic properties depends upon the partition and multiplicity of the energy states in regular solids. The spectral terms are investigated for a lattice of which the atoms or molecules in the ground state possess an electronic impulse, and consequently exhibit directional degeneracy in the undisturbed state. The lattice terms are capable of arrangement according to resultant impulse, falling into cyclic systems of which each is characterised by the wave-length of one associated resonance wave. The distribution of resulting impulses for characteristic-value perturbations is discussed: it appears that the entropy at absolute zero is not appreciably different from zero. The results are applicable to ferromagnetic lattices, in which the atoms in the ground state have an electronic impulse in addition to spin. F. I. G. R.

38. Periodic Arrangement of Atomic Nuclei. Prediction of Isotopes. H. L. Johnston. *Am. Chem. Soc., J.* 53. *pp.* 2866–2871, *Aug.*, 1931.—The author divides his table into four sections, the 4N type with atomic weights evenly divisible by four, possibly with nuclei composed of N α-particles; the 4N + 1 type, perhaps N α-particles and a "free" proton; the 4N + 2 and the 4N + 3 types. N may have any value from zero to about sixty. Values of N are plotted vertically downwards in each section, while the numbers at the heads of columns represent the numbers of the nuclear electrons in excess of 2N, the "free" electrons in the nuclei. Certain regularities appear in the four different sections, for example the number of free electrons is zero or an even number in sections 4N and 4N + 2, has both odd and even values from 0 to 14 in section 4N + 1, and the values 2, 4, 5, 6, 7, 8 and successive odd and even values up to 13 for 4N + 3. On the basis of the table many undiscovered isotopes are predicted, and the probable existence of certain isobaric triplets is pointed out, also significant relationships between the number of free protons and free electrons in the nuclei. Some of Harkins' abundance rules are amended. H. N. A.

39. Natural System of Atomic Nuclei. H. C. Urey. *Am. Chem. Soc., J.* 53. *pp.* 2872–2880, *Aug.*, 1931.—Plots the existing atomic nuclei in a diagram, in which ordinates represent the number of protons in the nucleus and abscissæ the number of electrons. Shows that in many cases three or more neighbouring nuclei lie along the same vertical line in the diagram, while in other cases several nuclei lie along a line inclined to the vertical. In some cases these vertical and inclined lines form parallelograms, some of which have a nucleus at each corner, and one at the middle of each side. These regularities make possible predictions in regard to unknown nuclei between A^{36} and Cu^{63}. A formula is proposed for nuclei, which are supposed to consist of helium nuclei, internal binding electrons, external protons and external electrons. It is shown that the isotopic isobars Io^{230} and UY may be expected. Barton's clusters in the diagram may be related to nuclear stability. The system proposed is compared with those suggested by other authors. H. N. A.

40. Isotopic Constitution and Atomic Weights of Se, Br, B, W, Sb, Os, Ru, Te, Ge, Re and Cl. F. W. Aston. *Roy. Soc., Proc.* 132. *pp.* 487–498, *Aug.* 1, 1931.—Measurements of the relative abundance of the isotopes of the above elements have been made by means of the photometry of their mass-spectra. A new and more sensitive type of

V.3
193

photographic plate was employed. The following table embodies the results:—

Elements.	Number of Isotopes.	New Isotopes.	Packing Fraction.	Atomic Weight (Calculated).	Atomic Weight (Chemical).
Se....	6	0	− 9·1 for Se^{80}	78·96 ± 0·04	79·2
Br....	2	0	—	$79{\cdot}916_5$ ± 0·002	(as calculated)
B	2	0	—	10·806 ± 0·01	10·82
Si	—	0	− 6·5 ± 1·0	—	—
W	4	4	about zero	183·96	184
Sb....	2	0	—	121·79	121·76
Os....	6	6	− 1 ± 2	190·31 ± 0·06	190·9
Ru ...	7?	7?	− 6?	101·1?	101·7
Te....	4	1	− 5 ± 2	128·03 ± 0·1	127·5
Ge ...	8	0	—	72·65 ± 0·05	72·6
Re ...	2	2	− 1 ± 2	186·22 ± 0·07	186·31
Cl....	2	0	—	uncertain	—

The percentage abundances of the different isotopes have been determined.

H. N. A.

41. Parachor Measurements and Constitution of Polysulphides and Polyselenides and [Organic] Chains containing both Sulphur and Selenium. A. Baroni. *Accad. Lincei, Atti,* 14. *pp.* 28–32, *July,* 1931.—Parachor determinations have been made with various diethyl polysulphides, polyselenides and polythioselenides. The results are satisfactory with compounds containing a straight chain of three S or Se atoms, and the method is therefore presumably applicable to the determination of the structure of the higher polysulphides. The probable structural formulæ of these compounds are given. H. F. G.

42. Euler's Equations and the Standard Equations of Mechanics. R. Einaudi. *Accad. Lincei, Atti,* 13. *pp.* 762–767, *May* 17, 1931.—The equations of Maxwell for electromagnetic waves and the equations of Dirac for material waves depend on a variational principle. The object of this mathematical note is to point out an intimate relation which exists between the most general equations of the type of certain Euler's equations and the standard equations of rational mechanics. This the author regards as opportune, especially in view of the importance of equations of this type in the problem of the quantisation of electromagnetic and material waves. J. J. S.

43. Interpretation of Dirac's Equation. G. Lemaître. *Ann. Soc. Sci. de Bruxelles,* 51. *pp.* 83–93, *Aug.* 8, 1931.—The invariance of the Dirac equation for an orthogonal transformation has given rise to a number of works which have progressively brought out the profound symmetry of these equations. The author deals particularly with Eddington's interpretation. He develops a number of theorems concerning the antisymmetrical matrices, and shows that the results obtained by Eddington for infinitesimal transformations subsist with the addition of a sixth dimension. E. E. F. d'A.

44. Present State of Dirac's Theory of the Electron. G. Rumer. *Phys. Zeits.* 32. *pp.* 601–622, *Aug.* 15, 1931.—This is a mathematical report giving an account of the development of Dirac's relativistic quantum mechanics from 1928 to May, 1931. The chief topics treated are the nature of energy and velocity operators, the application of the theory to spin, the representation of various operators by matrices, the use of wave functions, magnetic properties of spin, negative energy values and various problems connected with a hydrogen atom such as the determination of energy levels and rules of selection. The last section deals with general spin-vector or spinor analysis, in particular with transformations of wave functions, and Dirac's equation of continuity is obtained. N. D.

45. Application of Ritz's Method to Polarisation Problems in Wave Mechanics. Forces of Polarisation between Two Hydrogen Atoms. J. Podolanski. *Ann. d. Physik,* 10. 6. *pp.* 695–714, *Aug.* 11, 1931. —An attempt is made to calculate by wave mechanics the mutual polarisation of two hydrogen atoms in the same S-state. The form of the solution assumed can, in general, be brought into relation with its range with respect to the perturbation terms of the energy involved. Proceeding in this way, the proper function is established step by step by taking into account the energy of polarisation. The determination of the "free parameter" in the solution assumed was made by using Ritz's method. The parameters were so chosen that the calculation of one parameter, the "perturbation parameter," immediately gave the form of the "perturbation" energy in general. The numerical value can be approximated to as closely as we choose by introducing further parameters. The calculation was successfully carried out for all states of excitation for which $n > 1$, and an explicit formula was found for polarisability. For $n = 1$ calculation showed that good agreement existed, even for a first approximation with the value as obtained by the method of Eisenschitz and London. For $n = 2$ the calculated value as given by higher approximation also agreed well. H. L. B.

46. Integral Occurring in Wave Mechanics. J. Podolanski. *Ann. d. Physik,* 10. 7. *pp.* 868–872, *Aug.* 18, 1931.—In the wave-mechanical calculation of the exchange energy of two atoms the integral $\int^{(1)}(1)f^{(2)}(2)/r_{12}\,.\,d\tau_1 d\tau_2$ occurs, where $f^{(1)}$ and $f^{(2)}$ are, in general, complicated space-functions, which in the simpler cases represent layers of charge distributed confocally on rotational ellipsoids. By modifying a method due to Sugiura it is possible to calculate the value of this integral exactly for the most general functions that occur. The final formula only requires the evaluation of quadratures of the form $\int_{\infty}^{x} r(x)\, e^{-\mathrm{K}x}\,.\,dx$, where $r(x)$ denotes a whole rational function. H. L. B.

47. Reflections on the Wentzel-Brillouin Approximation Method in Wave Mechanics, in particular as Applied to the Ionised Hydrogen Molecule. Margarete Willstätter. *Ann. d. Physik,* 10. 7. *pp.* 873–887, *Aug.* 18, 1931.—The original object of the author was to calculate the distance between the nuclei and the energy-levels for the ionised hydrogen molecule by means of the approximative method of Wentzel and Brillouin. Difficulties involved in the method have, however, led to the paper being concerned rather more particularly with the general question as to the applicability of the method, and with the relationship between wave-mechanics and the older form of quantum mechanics. H. L. B.

48. Pauli's Exclusion Principle. W. Heisenberg. *Ann. d. Physik*, 10. 7. *pp.* 888–904, *Aug.* 18, 1931.—According to Pauli's exclusion principle there is considerable similarity between the terms of an atomic system with *n* electrons and those of a system in which *n* electrons are wanting to complete a shell. The equivalence of the system of *n* electrons with the system of *n* "holes" is exact so far as the *number* of terms is concerned, as has been shown by Pauli. The author discusses the equivalence that exists with regard to the position of the energy-levels by means of an approximation method. He uses as illustrations of the method the lowest terms of atomic spectra and the anomalous Hall effect. H. L. B.

49. Light Quanta and the Electromagnetic Field. J. R. Oppenheimer. *Phys. Rev.* 38. *pp.* 725–746. *Aug.* 15, 1931.—A so-called "extreme light-quantum theory" is developed, *i.e.*, a light-quantum theory more complete in certain respects than that of Dirac. From certain assumptions, the wave equation for the de Broglie waves of a quantum of light is deduced. This is of a more general character than that of Dirac. Special solutions are considered, and a selection rule is obtained. Relations between the solutions and certain solutions of Maxwell's equations are discussed. Defects of the theory associated with the spinorial form of the wave equations are considered. The Heisenberg-Pauli theory of an electromagnetic field is then given, with certain minor formal changes. The two theories agree in many points, but on the questions of zero-point energy and negative energies of quanta are irreconcilable. For various reasons, the extreme light-quantum theory is considered unsatisfactory. N. D.

50. Schrödinger Potential Function. R. M. Langer. *Phys. Rev.* 38. *pp.* 779–796, *Aug.* 15, 1931.—It is proposed to deal with the difficulties of Klein and of the negative energy-levels in Dirac's equation by an alternative to Schrödinger's hypothesis that "only even operators exist," namely, by supposing that the fundamental potential between charges is an even operator. It is shown that this assumption ought to be verifiable experimentally; for the hyperfine structure separation and the X-ray levels of heavy atoms ought both to depend markedly on whether the Coulomb potential or only its even part acts on the electron. G. C. McV.

51. Quantum Theory of Born and Wiener. R. J. Seeger. *Washington Acad. Sci., J.* 21. *pp.* 315–319, *Aug.* 19, 1931.—A mathematical paper, in which the motion of a particle in a uniform field of force is determined by the method of Born and Wiener. The expression obtained for the positional coordinate is the same as theirs. The question of the application of the Hermitian condition in certain cases is discussed. N. D.

52. Zero-Point Energy of Radiation and the Quantum Theory of Gravitation. J. Solomon. *Zeits. f. Physik*, 71. 3–4. *pp.* 162–170, *Aug.* 15, 1931.—Theoretical difficulties associated with the notion of zero-point energy of radiation, *i.e.*, with the energy of the gravitational field produced by electromagnetic waves, are briefly discussed [see Abstract 3341 (1930)]. A second order of approximation to the energy of the gravitational field is derived, and it is shown that the mutual energy of a light-quantum and its associated gravitational field, calculated in accordance with the Heisenberg-Pauli theory, is always infinite in value. The author concludes that the expression for the mutual action of quantum and field in accordance with quantum theory is, in the present connection, unjustified. J. S. G. T.

53. Relativity and Rigid Transport. P. Nalli. *Accad. Lincei, Atti*, 13. *pp.* 837–842, *June* 5, 1931.—Points out that what Einstein calls absolute parallelism has been styled by the author rigid transport with unique result, and discusses the various ways in which it can be expressed analytically. E. E. F. d'A.

54. Relativity Theory. T. de Donder. *Annales de l'Inst. H. Poincaré*, 1. 2. *pp.* 77–116, 1931.—A formal treatment of the field equations of relativity theory based on the Hamiltonian differentiation of invariants. By taking the sums of suitably chosen invariants, field equations for both gravitational and electromagnetic fields are obtained. The variation of still another invariant gives Schrödinger's wave equation in generalised coordinates and a relativistic form of Dirac's wave equations is obtained by supposing that the four ψ-functions can be expressed in terms of eight functions analogous to the components of electromagnetic force which occur in Maxwell's equations. G. C. McV.

55. Moment Distributions of Moments in the Case of Samples Drawn from a Limited Universe. L. Isserlis. *Roy. Soc., Proc.* 132. *pp.* 586–604, *Aug.* 1, 1931.—A method permitting the comparatively simple calculation of the first few moments of the distribution of the lower sample moments in a limited universe of samples is developed. J. S. G. T.

56. Non-Static Model of Universe with Reversible Annihilation of Matter. R. C. Tolman. *Phys. Rev.* 38. *pp.* 797–814, *Aug.* 15, 1931. —An application of the author's relativistic thermodynamics to a universe filled with a mixture of perfect monatomic gas and radiation. The gas and the radiation are in equilibrium. It is assumed that the expressions for the total pressure and total density of such a mixture obtained from classical thermodynamics (*i.e.*, for a flat space-time) still hold in a curved space-time of variable radius. Then it is shown that reversible transformation of matter into radiation can take place without change of entropy of the universe as a whole. Also, if matter is changing into radiation, and not being reconverted, the radius of the universe must be expanding. An observer measuring the entropy of the portion of the universe in his immediate neighbourhood would conclude (if he were unaware of the expansion of space) that there was a continual increase of entropy in his neighbourhood. G. C. McV.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

57. Phenomena of the Upper Atmosphere. S. Chapman. *Roy. Soc., Proc.* 132. *pp.* 353–374, *Aug.* 1, 1931.—The ozone layer, maximum 50 km., is formed by aid of atomic O, produced by dissociation of molecular O_2 by radiation of $\lambda < 1850$ [see Abstract 381 (1931)]. It is shown mathematically that the ratio $O_3 : O_2$ decreases indefinitely with height above 60 km., that of $O : O_2$ increasing similarly above 80 km., where it is 1: 300, and 1: 3 at 120 km., atomic O becoming ultimately the chief constituent of the atmosphere, while hydrogen is negligible. The upper ionisation layer, maximum 220 km., consists mainly of ionised atomic O^+, and free electrons, produced by radiation of $\lambda < 910$, with small amounts of ionised molecular N_2^+ and O_2^+, for which radiation of $\lambda < 770$ is necessary. The lower ionisation layer, maximum 100 km., is due to neutral particles emitted by the sun, which with similar, but charged particles, penetrate to about that height, the latter then moving to the poles under the earth's magnetic field. These ionise molecular N_2, the electrons attaching themselves to atomic O [see Abstract 1189 (1931)]. The green light of the night sky, λ 5577, is caused by transition of atomic O from a metastable state [see Abstract 473 (1931)], the energy producing which, amounting to about 4 % of that utilised in ionising the upper layer, is stored during the day as energy of dissociation and perhaps also ionisation, the amount of such dissociated material being large compared with the amount of metastable O produced. This light is emitted in either the lower ionisation layer at about 160 km., or that of atomic O at about 100 km.
C. A. S.

58. Tidal Oscillations in Rectangular Basins. G. R. Goldsbrough. *Roy. Soc., Proc.* 132. *pp.* 689–701, *Aug.* 1, 1931.—The general problem of tidal waves in a rotating rectangular basin is dealt with by a new method. It is shown, in disagreement with Taylor's results, that there are more than a single infinity of distinct normal modes of oscillation; and that one member of each of the pairs of such modes consists of a wave system travelling round the basin in the direction of rotation, the other of a system travelling in the opposite direction. Applied to special cases, results in agreement with those of Lamb, but not of Rayleigh, are deduced. C. A. S.

59. Origin of the Solar System. J. H. Jeans. *Frank. Inst., J.* 212. *pp.* 135–145. *Aug.*, 1931. *Nature*, 128. *pp.* 432–435, *Sept.* 12, 1931.—The birth of planets is an abnormal and exceedingly rare event in the life of stars. From the uranium in our rocks we can calculate that about 1500 million years have passed since the earth's crust solidified, and the total age of the earth, and probably of other members of the solar system, is about 3000 million years. The rate at which the sun is radiating away its substance proves that its mass, and hence its physical constitution, must have been nearly the same 3000 million years ago as at present. This fact rules out the nebular hypothesis of Laplace, and other hypotheses fail to explain the formation of the satellite systems of the planets. The theory of a near approach to the sun of another star, causing an exaggerated tidal wave which shot out in a long filament and then broke up, explains not only the existence of the planets, but also their relative positions in

the system according to their mass and density, the formation of satellite systems and their general resemblance to the main system, the rings of Saturn and the asteroids, and the respective numbers and sizes of the satellites according to position in the system. There are many conjectural elements in this theory, but no insuperable objections have been found, If true, our human life forms a large fraction of all the life of the universe.
M. A. E.

60. Significance of Bode's Law in Relation to Satellite Systems. V. V. Narliker, and Note by J. Larmor. *Phil. Mag.* 12. *pp.* 67–72, *July*, 1931.—If Bode's law is not accidental there should be a cognate relation for the satellite systems. Narliker states the law in the form $\log(d - 0{\cdot}04) = \log 0{\cdot}015 + 2{\cdot}72n \log (1{\cdot}29)_{n=1, 2, \ldots 8}$ (where n is an integer); in which form it does not hold good for Mercury ($n = 0$) and Neptune ($n = 8$), but does for Pluto ($n = 8$); he applies it to Saturn (first 5 satellites), Uranus and Jupiter (4 largest satellites), obtaining the relations $A + C\,.\,4n$, $A' + C\,.\,6n$, $A'' + 3{\cdot}8n$ and $A''' + C\,.\,11n$ for the three planets and the solar system respectively. That is, the log distances of positions of planets and satellites are for all the systems of the type Const. $+ Cm$, where m is an integer, but only a few of these possible positions, sets of equidistant ones, are occupied in each case, the others not having acquired a satellite. **Larmor** goes into the previous history of such an enquiry [see Abstracts 3299 (1929) and 78 (1931)], especially into a discussion by Miss M. A. Blogg [see Abstract 1603 (1913)], who gave the relation $\log (d/A) = n \log 1{\cdot}7275 + \log \{B + f(\theta)\}$, $\theta = \alpha + \beta n$ (n being an integer); here the last term is of the nature of a correction to the main term, and the graph for $f(\theta)$ presents itself as a unique universal graph common to all satellite systems.
A. S. D. M.

61. Radial Velocities of all Stars. H. Mineur, L. Varchon, D. Barbier, Mme H. Mineur, Renée Canavaggia, R. Chevallier, Marguerite Roumens. *Bull. Astronomique*, 6. 9. *pp.* 355–397, 1930.—The authors develop the mean radial velocity (ν) of the stars classified according to spectral type and distance from the sun. From these, the apex and coefficients of differential rotation are deduced for the stellar groups of (1) all stars, (2) red giants, (3) B, A and F stars, and (4) dwarfs. With respect to the Galaxy, α, β, γ are cosine directors, l and b are longitude and latitude, and z is the stellar distance from a plane through the sun parallel to the galactic plane. An equation is obtained:

$$\nu = K + a_1X_1 + a_2X_2 + a_3X_3 + b_1Y_1 + \ldots + b_5Y_5 + c_1Z_1 + \ldots + c_7Z_7$$

where $X_1 = \alpha$, $Y_1 = 2\beta\gamma$, $Y_4 = \alpha^2 - \beta^2$, etc. K gives the tendency of the stellar system to disperse in space (when positive); for B stars, it depends on distance diminishing from $+ 4{\cdot}6$ to $+ 2{\cdot}7$ (for stars at 100 parsecs distance); for other classes it is practically nil. X_1, X_2, X_3 give the sun's displacement towards the apex; this is near Boss's P.G. Catalogue value, $\alpha = 274°$, $D = + 33°$. Y_3, Y_4 gives Oort's differential equation (Oort terms); for giant and helium stars these are identical with those found by Oort and Plaskett; for A stars they are slightly greater than Oort's; but for F stars they are $3 \cdot 5$ times greater. b_5Y_5 gives the flattening at the poles of the stellar systems; it is apparent (slightly) for B stars only. Z_6, Z_7 give the 3rd order differential rotation (Dyson terms), and define the centre of longitude. Y_1, Y_2, Z_1, Z_2 give the variation of solar velocity with latitude, and indicate for the red giants and the A stars a dependence on distance, but the results are less clear for B and F stars. Tables and diagrams are given for these values in the various stellar categories. A. S. D. M.

62. Influence of a Secular Decrease of Mass on the Dynamics of Star Systems. K. Pilowski. *Zeits. f. Astrophysik*, **3.** 1. *pp.* 53–56, *June* 29, 1931.—By the introduction of a secular mass decrease in the Lindblad-Oort Star System, a coherent explanation is obtained of certain phenomena which hitherto could not be embraced by the theory of galactic rotation. These phenomena are the mean K-effect, the deviation of the vertex from the direction of the galactic centre, and the deviation of the direction of asymmetry from the perpendicular to the galactic centre. For the explanation of these phenomena, a mass decrease of $dM = 1 \cdot 0 \times 10^{-8}$ M per annum is necessary, an amount which has been used by H. Vogt in his explanation of the form of spiral nebulæ. J. E. K.

63. Polytropic Index of a Stellar Model. E. Hopf. *Zeits. f. Astrophysik*, **3.** 1. *pp.* 67–76, *June* 29, and **3.** 2. *pp.* 108–115, *Aug.* 11, 1931.—It is shown that the linear form to which Emden's equation can be reduced still holds when the polytropic index is variable. The theorem is then proved that the limit of $\rho P^{-n/n+1}$ (ρ = density, P = total pressure, n = variable polytropic index) at the surface, is never less than the limiting value it would have if n were equal throughout to n_0, the value in the outer layers. From this it follows that the luminosity of a star with an outer layer of perfect gas and material giving a polytropic index $n \leq 3$ within, can never fall below the luminosity of a complete perfect gas star. Proofs are also given of the theorems concerning the classification of solutions of Emden's equation for constant n into the three groups: centrally-condensed, Emden and collapsed solutions [see Abstract 1142 (1931)]. G. C. McV.

64. Absorption Coefficient of Degenerate Gas. Bertha Swirles. *Roy. Astron. Soc., M.N.* 91. *pp.* 857–862, *June*, 1931. The absorption coefficient of a degenerate gas is evaluated on the lines of quantum mechanics. It is found that the absorption of radiation by a free election in an encounter with a positive nucleus contributes much more to the total absorption than that of an election bound to an atom. The mean absorption coefficient is found to vary inversely as the square of the temperature. Numerically, for high degeneracy, the absorption coefficient of the degenerate gas is much smaller than that of a non-degenerate gas at the same temperature [see also following Abstract]. G. C. McV.

65. Stellar Coefficients of Absorption and Opacity. S. Chandrasekhar. *Roy. Soc., Proc.* 133. *pp.* 241–254, *Sept.* 1, 1931.—A calculation of the absorption and opacity coefficients of both degenerate and non-degenerate gases is made on the Fermi-Dirac Statistics, the results for the degenerate gas being substantially the same as those given by Miss Swirles [see preceding Abstract]. The atomic absorption coefficient and the atomic opacity coefficient for either phase are found to differ considerably. Various other questions in connection with these coefficients are discussed. G. C. McV.

66. Hydrogen and Helium in Stellar Atmospheres. A. Unsöld. *Zeits. f. Astrophysik*, **3.** 2. *pp.* 81–104, *Aug.* 11, 1931.—The number N_2H of absorbing H atoms in the two-quantum state (per sq. cm. of photosphere) is calculated for the stars of spectral type B0 to K5 from C. H. Payne's observations of the line contours, and from C. S. Yü's observations of the continuous spectrum beyond the head of the Balmer series. The theory of the Balmer continuum in stellar spectra is developed. Application of Milne's theory to the calculated N_2H value shows that H is very abundant in the atmosphere of stars. From the observations a new value of the constant α in Milne's equation for the absorption coefficient $x=\alpha.P.(KT)^{-9/2}$ is determined, and a value $\alpha = 5\cdot10^{-55}$ is obtained for hot stars. In hot stars the free electrons come chiefly from H, and in the cooler ones from the metals. This must be taken into account in the calculation of x. For the number of excited atoms of He in the 2^1P-state in B-stars it is possible to calculate a lower and upper limit from C. T. Elvey's observations. Application of Milne's theory leads to an abundance ratio He : H (in numbers of atoms) of about 1 % (limits, $\sim 0\cdot25$ % to 4 %). From observations of Payne, Struve and Higgs the ratio Ca : H is estimated. The following abundance ratios (in logarithms to base 10) of H, He and Ca in stellar atmospheres are obtained

$$H : He : Ca = [0\cdot0] : [-2\cdot0 \pm 0\cdot6] : [-3\cdot0 \pm 0\cdot8]$$

These ratios are in good agreement with estimations of H. N. Russell made in a different manner and they may now be considered as established approximate values. An attempt is made to show that H and He are also predominantly abundant in the interiors of stars. This opens up the possibility of explaining Eddington's well-known discrepancy between the physical and astronomical values for the opacity of stellar interiors. J. E. K.

67. Numerical Integration in Stellar Structure. L. Biermann. *Zeits. f. Astrophysik*, 3. 2. *pp.* 116–128, *Aug.* 11, 1931.—Two models of perfect gas with coefficients of opacity $k \propto \rho/T^{3/5}$ are investigated by numerical integration. In one model energy generation is constant throughout the star, in the other there is a point source of energy at the centre. The homology transformation is found for the case when the mass inside radius r tends to zero with r. Hence one numerical integration is sufficient to give all such models. Comparing the results obtained with observation, it appears that the actual stars conform rather to the models with a point-source of energy [see also Abstract 3021 (1931)]. G. C. McV.

68. Stellar Structure. A. S. Eddington. *Zeits. f. Astrophysik*, 3. 2. *pp.* 129–141, *Aug.* 11, 1931.—The heat of stars is maintained, it is now generally agreed, by the release of sub-atomic energy in the interior, which has a temperature of $4 \times 10^{7\circ}$ C. In Milne's theory, it is $10^{11\circ}$ C., which is apparently more suitable for the release of such energy, but the only theory of release which has been developed in any detail, that of Atkinson and Houtermans, definitely requires the lower temperature, and Milne's hypothesis of extremely hot, extremely dense stellar centres has no foundation in present knowledge. His polytropic cores, and his arguments regarding opacity and secular stability are discussed, and it seems impossible to fit his centrally-condensed stars into any stage of stellar evolution. The discovery of extremely dense stars such as the companion of Sirius suggested a new investigation into the theory of ordinary stars, taking into account new possibilities with regard to density, but this investigation led once more to the conclusion that Milne's theory is untenable. M. A. E.

69. Star Streams. J. Schilt. *Astron. J.* 41, *No.* 959. *pp.* 97–104, *Aug.* 24, *No.* 960. *pp.* 105–111, *Aug.* 31, 1931.—The number of stars with a given proper motion in a given region of the sky is plotted against the proper motion. The resulting curves show maxima and minima. This is interpreted as meaning that certain preferential values in the frequency distribution of proper motions exist. The same holds for radial velocities. The continuity of these diagrams on passing from one region of the sky to an adjacent one is demonstrated. By comparing the diagrams for regions lying along a complete circle of the sphere the values +13, + 4, + 5 km./sec. are found for the components of the solar motion [see also Abstract 96 (1930). G. C. McV.

70. Large Magellanic Cloud. H. Shapley. *Harvard Coll. Obs. Bull. No.* 884. *pp.* 1–10, *Aug.*, 1931.—A list of 166 galactic clusters in the large Magellanic Cloud is given which includes the position, diameter and magnitude of the fifth brightest star of the cluster. The maximum absolute luminosity of the cluster stars is found to vary very greatly from system to system. Hence the parallaxes of galactic clusters are likely to be highly uncertain if based on an assumed mean absolute magnitude for the brighter stars. G. C. McV.

71. Harvard Programme of Galactic Explorations. H. Shapley. *Science,* 74. *pp.* 207–212, *Aug.* 28, 1931.—Eight different schemes of work are in progress: (1) the solar neighbourhood: stars up to 50 light-years from the sun. These are mostly dwarfs. (2) The determination of spectroscopic parallaxes and other properties of the brighter stars. (3) The cataloguing of the local system. (4) The structure of the Milky Way star clouds, chiefly based on the study of Cepheid variables in these clouds. (5) The globular clusters. (6) The clouds of Magellan. Supergiants in the clouds, open clusters and variable stars are receiving special attention. (7) The study of groups of extra-galactic nebulæ. (8) The structure of the universe as a whole with regard especially to the space distribution of galactic systems and their distances. G. C. McV.

72. Possible Origin of Diffuse Nebulæ and of Interstellar Matter. B. Vorontsov-Velyaminov. *Observatory,* 54. *pp.* 216–220, *Aug.*, 1931.—It is thought by many that diffuse nebulæ and interstellar matter are remnants of the original nebulosity out of which our galactic system has developed. But, on the other hand, it has recently been established that gaseous matter is now being continuously scattered into space, from Wolf-Rayet stars and Novæ. From a classification of the nuclear spectra of planetary and diffuse nebulæ, and a determination of nuclear temperatures, made by the author, it appears that there is a regular progression from small planetaries with emission O-type nuclei, through larger planetaries with absorption O-type nuclei, to large diffuse nebulæ connected with B-type stars, the temperature decreasing as size increases. It seems possible that this represents the progress of evolution, and that the stars which stimulate nebulæ into luminosity were themselves, in past ages, nuclei of planetary nebulæ or collapsed stars. M. A. E.

73. Photovisual Star Magnitudes. E. Hertzsprung. *Zeits. f. wiss. Phot.* 30. *pp.* 171–173, *Aug.*, 1931.—Points out the advantages of a combination of an erythrosin plate with a yellow filter for the estimation of stellar magnitudes. Gives a table of temperatures of 2000°–20,000° C. and the corresponding radiation, assuming this to be that of a black body like the sun. The magnitudes range from 6·4 to — 3·8. E. E. F. d'A.

LIGHT.

74. Colorimetric Properties of the Spectrum. J. Guild. *Roy. Soc., Phil. Trans.* 230. *pp.* 149–187, *June* 24, 1931.—A " mixture curve " can be obtained for the normal eye giving the visibility and the colorimetric effects as functions of the wave-length. The visibility function has been known to a high degree of accuracy for some time, but the data in connection with the colorimetric properties has been meagre, and the tendency has been to elaborate and correct earlier results rather than to perform new experiments. The present paper describes a research on seven subjects, which is in such close agreement with similar work on ten subjects by Wright, using the same conditions as to source of white light, that it is considered to give results closely approximating to the " normal." No standard for " white " light for colorimetry has yet been agreed upon, but, if an international standard, different from that used in the research, is adopted, no difficulty will be found in transforming results. Details of experiment, diagrams and tables of results are given. H. M. B.

75. Weber's Law and the Yellow Spot Effect. R. A. Houstoun. *Phil. Mag.* 12. *pp.* 538–551, *Aug.*, 1931.—In former papers [see Abstracts 423 and 424 (1931)] the author showed that König and Brodhun's observations on the least perceptible increment in intensity of light could be represented by a probability curve when they were graphed as $I/\Delta I$ against log I. In the present paper an account is given of further experiments made by means of one of the methods described in the second paper quoted above. Various results bearing on physiological optics are given. An investigation was made of the effect of colour on the least perceptible difference. In ten sets of readings no difference was revealed. The effect of dark adaptation was studied, and the change with time was found to be very marked. A series of observations was made for red over a wide range of illumination by the method of least perceptible difference, which had proved more accurate than other methods. These observations were made by 9 different observers, each of whom made about 10 independent sets of readings. The mean results are given in a table. When graphed, the results for the different observers vary considerably, but are much more regular when integrated graphically. From the diversity in the shapes of the curves, it is clear that if a connection is to be sought between the variation of intensity and of acuity with intensity, both sets of readings must be made by the same observer. If a red and a blue light of low intensity are compared by a wedge photometer, the result varies with the distance of the eye from the photometer. When the eye is near, the ratio of red to blue is greater than when it is far away. Whether this is due to the action of the yellow spot is discussed, and an account of experiments is given. It is concluded that the yellow spot is not yellow enough to form the basis of an explanation. The effect is connected with dark adaptation. At very high intensities, moreover, the eye shows a reversed yellow spot effect: probably fatigue for red and blue is different in the different parts of the retina. Since the yellow spot effect is due to the passage from the photopic to the scotopic mechanism it arises from the same cause as the Purkinje effect. J. J. S.

76. Experimental Test of a Possible Partial Absorption of Light Quanta. P. Kunze. *Ann. d. Physik,* 10. 5. *pp.* 529–532, *July* 29, 1931.—An effect involving the partial absorption of light quanta has been observed in the X-ray region by B. B. Ray [see Abstract 1561 (1931).] The present experiment is designed to test whether an analogous effect occurs when ultra-violet light of wave-length 2536 Å. from a mercury vapour lamp is absorbed by sodium or potassium vapour. The result was negative, and the author infers that, if the effect exists at all, the intensity ratio of the transformed to the primary frequency in the visible region must be several orders of magnitude lower than in the X-ray region, where Ray found this ratio to be 1 : 400 to 1 : 500. [See also Abstract 134 (1932).] H. L. B.

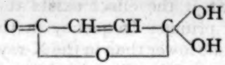
77. Copper Salts as Light Filters. W. V. Bhagwat and N. R. Dhar. *J. Phys. Chem.* 35. *pp.* 2383–2411, *Aug.*, 1931.—An examination is made of the absorption, extinction coefficient and percentage transmission for the visible region of (*a*) cupric chloride, nitrate and sulphate; (*b*) picric acid, methyl violet, potassium chromate and a number of other substances; (*c*) combinations of individual members of the two groups (*a*) and (*b*). In addition, in each case, the absorption for the ultra-violet has been examined. Comparison is made throughout with commercial filters covering the same regions and, in certain cases, it is found that the liquid filter is the more efficient. A list of filters suitable for photochemical investigations is given. A. H.

78. Light Absorption in Copper Glycocoll Solutions. R. Luther and W. Eichler. *Zeits. f. wiss. Phot.* 30. *pp.* 174–176, *Aug.*, 1931.—Gives the extinction coefficient for 50 different wave-lengths of a glycocoll copper solution. The strength was 1/50-molecular, or 4·593 gm. $(NH_2 . CH_2 . COO_2) . Cu + H_2O$ in 1 l. solution. The extinction was 0·651 at wave-length 700, 0·800 at 667·8, 0·706 at 580, 0·232 at 520 and 0·009 at 440 mμ. E. E. F. d'A.

79. Spectrographic Study of Compounds of Tartaric Acid, with Copper. J. Giuntini. *Comptes Rendus,* 193. *pp.* 340–342, *Aug.* 17, 1931.—The absorption for various wave-lengths from λ2340 to 7000 by a similar [see Abstract 1168 (1931)] series of mixtures of tartaric acid and cupric oxide is of the order of ten times that of solutions of cupric chloride of corresponding strength. This is attributed to part of the copper in $C_4H_4O_6Cu_2, nH_2O$ forming a complex and agrees with Darmois' views [see Abstract 464 (1929)]. C. A. S.

80. Ultra-Violet Absorption of the Geometrical Isomers of Stilbene and of Cinnamic Acid. A. Smakula and A. Wassermann. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 353–365, *Aug.*, 1931.—The position and intensity of the absorption between 3200 Å. and 1800 Å. due to the —C : C— in the *cis* and *trans* forms of stilbene and cinnamic acid are found to depend (1) on the nature of the groups present—the maximum for stilbene is at longer wave-lengths than for cinnamic acid; (2) on their spatial arrangement—the intensities are twice as great, and the maxima are at longer wave-lengths, for the *trans* forms; (3) on the solvent. There is no effect in the stilbenes, but in the *cis*-cinnamic acid, the maximum moves to shorter wave-lengths with increase of dielectric constant of the solvent, while for the *trans*-acid, no simple relationship holds. C. B. A.

81. Ultra-Violet Absorption and Isomerism of Maleic and Fumaric Acids. A. Wassermann and A. Smakula. *Zeits. f. phys. Chem.* 155. *Abt. A*. 5–6. *pp.* 366–377, *Aug.*, 1931.—The absorption spectra of the maleic acids, maleic anhydride, the fumaric acids and of the *l*-menthyl and dimethyl esters all show an absorption band due to the ethylenic bond at about 2000 Å. The influence of the constitution on its position and intensity are discussed, and also their dependence on the solvent. The cyclic formula



for maleic acid is supported not only by the refraction and dissociation constants, but also by the absorption spectrum evidence. C. B. A.

82. Ultra-Violet Absorption of Ethyl Alcohol Purified by Different Methods. P. A. Leighton, R. W. Crary and L. T. Schipp. *Am. Chem. Soc., J.* 53. *pp.* 3017–3019, *Aug.*, 1931.—Since the absorption spectrum of ethyl alcohol in the threshold region (2500–3000 Å.) varies considerably with the quantity and nature of the impurities present, the efficacy of different methods of purification may be investigated spectrometrically. The experiments described show that drying over CaO should be carried out in an oxygen free atmosphere, as otherwise oxidation of the ethyl alcohol takes place, and that Al amalgam affords a very effective means of purification. The iodine-zinc method is not particularly satisfactory. H. F. G.

83. Restoration of Solarised Ultra-Violet Transmitting Glasses by Heat Treatment. A. Q. Tool and R. Stair. *Bureau of Standards, J. of Research*, 7. *pp.* 357–374, *Aug.*, 1931.—It is found that temperatures within the annealing range are most effective in restoring the transmission of solarised glass. Treatment at higher temperatures causes deformation and surface deterioration, whilst lower temperatures only partially rejuvenate. Visible colorations, which accompany the diminution in transmission, disappear at temperatures which are too low to restore the transmission completely. The thermoluminescence, accompanying the disappearance of coloration on heat treatment, grows more intense and of shorter duration as the temperature of the heat treatment is raised. A. H.

84. Calibration of Abbe Refractometer. L. E. Dodd. *Rev. Sci. Instruments*, 2. *pp.* 466–501, *Aug.*, 1931.—The usual form of Abbe refractometer with compensating prisms restricts measurements of the refractive index (n) for a liquid to one wave-length, usually λ_D. With a graphical chart, or numerically, the dispersion ($n_F - n_C$) of the liquid can be obtained approximately. The author shows that this approximation varies with n_D. When n_D is high (*e.g.*, 1·627 for CS_2) the error is about 5 % but when low (*e.g.*, 1·330 for CH_3OH) it may be 30 % or more. The author provides a method of calibration and also the necessary equations which permit any fixed setting of the prisms and give n for any wave-length. Then from index values of n_F and n_C or, using other wave-lengths and Cauchy's formula if these are not available, the average difference of the dispersion from published values is found for five other liquids, with n_D between 1·330 and 1·627, and using four different wave-lengths, to be $< 5\%$. The dispersion of a test sample can then be checked on the same instrument. R. S. R.

85. Equivalent Refraction of Strong Electrolytes at Various Temperatures. Part I. P. Hölemann and H. Kohner. Part II. Z. Shibata and P. Hölemann. Part III. K. Fajans, P. Hölemann, and Z. Shibata. *Zeits. f. phys. Chem.* 13. *Abt. B.* 4–5. *pp.* 338–372, *Aug.*, 1931.—Experimental methods are developed whereby it is possible to determine the equivalent refraction of solutions of strong electrolytes up to temperatures of 45° C. with an accuracy of ± 0·000012. The dependence of the equivalent refraction on concentration was determined for NaCl, KBr, $NaClO_4$, KCl, NaBr, KI, NH_4Cl, $BaCl_2$ in aqueous solutions at the temperatures 25°, 35°, 45° C. The Pulfrich refractometer was used with a special means of controlling the temperature. The results are discussed and it is shown that it is not possible to draw definite conclusions on the change of degree of association with the temperature from them.

F. J. B.

86. Refractive Indices of Dilute Solutions by an Interferometer Method. A. E. Brodsky and J. M. Scherschewer. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 417–430, *Aug.*, 1931.—A Zeiss interferometer is used to measure the refractive indices of solutions of KCl and KNO_3 between 0·1 and 0·004 *N*, for three wave-lengths and two temperatures. Results are given to six places of decimals. Errors and limits of exactness are discussed, the former are eliminated where possible and corrections, experimentally confirmed, are made in other cases. A greater exactness is obtained than with a refractometer. H. M. B.

87. Prism Polarisers, with Normal Field, Based on Internal Reflection. A. Cotton. *Comptes Rendus*, 193. *pp.* 268–271, *Aug.* 3, 1931. —A prism, constructed of calcite or quartz, is described, which polarises a beam of light while deviating it through a right-angle. The section is a 45° isosceles triangle, with the rectangular faces normal and parallel respectively to the optic axis, while the light must be incident on the normal face. If used as an analyser, the position is reversed. After total internal reflection, two beams emerge, the ordinary ray being normal to the second prism face. The extraordinary ray can be cut off by means of a screen, the angular separation in calcite being over 10°. It is of about the same order as that for a Rochon prism using double the material, while this new arrangement removes the necessity for the film of balsam required in a nicol. C. B. A.

88. Dispersion of Polarisation of Light-Scattering. K. S. Krishnan and A. Sarcar. *Indian Journ. Phys.* 6. *pp.* 193–205, *Aug.*, 1931.—A study is made of the polarisation of the various mercury lines after scattering from liquid benzene. It is found that over the range of wave-lengths investigated (λ5790 to λ3126) the depolarisation factor does not change. Previous results showing a variation of this factor are held to be due to polarisation produced by the quartz spectrograph employed. A method of overcoming the polarisation due to the instrument is described.

A. H.

89. Photodichroism and Photoanisotropy. Photographic Investigations with Polarised Light. Parts I and II. F. Weigert and F. Stiebel. *Zeits. f. wiss. Phot.* 30. *pp.* 95–107, *Aug., and pp.* 177–195, *Sept.*, 1931.—A summary of the work of the first-named author during the last few years on the effects of plane-polarised light on sensitive media. These effects are, briefly, that isotropic media are rendered dichroitic and doubly-refracting by plane polarised light, the optic axis of the now anisotropic medium being in the same direction as the vibrations of the exciting light. The marked influence on the effect of certain reagents, notably *p*-phenylene diamine, has enabled more detailed studies to be made. It is shown that even in cases where the polarised light is so weak that through it alone neither blackening nor dichroism is produced, a previous or subsequent treatment with ordinary light results in a strong effect. By producing simultaneously anisotropic and isotropic latent images new ideas on the nature of the latent image and on the photographic process have been obtained. The following facts appear to emerge: (1) There are two factors in the building up of a developable latent image—a form factor and an activating factor. (2) Metallic silver acts both as an activator and a sensitiser. (3) It should be possible to estimate the effective part of the original silver by the sensitivity increase of the photographic emulsion. (4) The reversal of the indications of photodichroism by treatment with chromic acid gives a means of further studying the Albert effect. (5) A lasting alteration to anisotropy of the silver halide can be shown even when further development is not possible. (6) By the difference of the effects of the sulphur-containing and therefore active-grain stripping developer, *p*-phenylene diamine and iron oxalate respectively, some indication of active-grain development growth and micelle changes can be obtained. (7) Inside the active grains polarised light induces a further and weaker dichroism. The next part will show how on the basis of these results the production of a photographic image may be pictured. J. E.

90. Law of Photoelastic Extinction. J. Kuno. *Phil. Mag.* 12. *pp.* 503–511, *Aug.*, 1931.—When a medium under stress is placed in a beam of monochromatic light between crossed nicols, the field is dark at certain points. This is called photoelastic extinction. A law is obtained and experimentally justified, showing that the principal stress difference multiplied by the thickness of the specimen is proportional to the order of extinction. Phenolite seems to be preferable to glass, celluloid or bakelite as a specimen for photoelastic observations. H. M. B.

91. Optical Activity Dependent on Coordinated Nickel. G. T. Morgan and F. H. Burstall. *Chem. Soc., J. pp.* 2213–2218, *Aug.*, 1931.—Tris-*aa'*-dipyridylnickelous chloride, bromide, iodide, nitrate, carbonate and tartrate have been prepared as hexahydrated salts, whereas the thiocyanate gives a trihydrate. In stability and colour these salts are comparable with the deep red coordination compounds obtained from ferrous salts and *aa'*-dipyridyl, two of which were resolved into optical forms by Werner. The resolution of the nickel salts has now been accomplished, two enantiomers of tris-*aa'*-dipyridylnickelous chloride hexahydrate having been obtained in *d*- and *l*-rotatory forms, in which the activity is dependent on coordinated nickel. The active salts racemise rapidly in aqueous solution, but are more stable in the solid state. Experimental details are given. C. B. A.

92. Influence of the Solvent on Optical Rotation. W. Kuhn, K. Freudenberg, and R. Seidler. *Zeits. f. phys. Chem.* 13. *Abt. B.* 4–5. *pp.* 379–382, *Aug.*, 1931.—The optical rotation of $C_6H_5 . CH . (CO . (CH_3)_2) . (OCH_3)$ dissolved in hexane is positive and has a sharp maximum at 2460 Å. The rotation wave-length curve is shown to be the sum of two absorption curves, *viz.*, that at about 2300 Å., due to the phenyl group, and that representing the amount of rotation contributed by the other absorption bands of the molecule, which lie in the far ultra-violet; the former is positive and the latter is negative. For the pure solute the magnitudes, but not the signs, of these two quantities vary, and as a result the rotation is negative throughout the visible spectrum. The direction of the optical rotation of a compound is therefore of no particular fundamental significance. H. F. G.

93. Magnetic Rotatory Dispersion of Sulphur in Solution. T. Hori and A. Okazaki. *Zeits. f. Physik*, 71. 5–6. *pp.* 350–361, *Aug.* 29, 1931. *Ryojun Coll. Eng., Mem.* 4. 4*a*. *pp.* 257–268, *Aug.*, 1931.—The applicability of the Savart double-plate to exact measurement of rotatory dispersion is discussed. Using the plate for photographic measurements, the magnetic rotatory powers of CS_2 and of solutions of sulphur in it are determined. The rotations due to sulphur, deduced by means of the Schönrock mixture rule, show that the rotatory power is independent of concentration, and thus that carbon disulphide has no chemical influence on the sulphur. The Verdet constants of S are given for ten wave-lengths. C. B. A.

94. Plano-Convex Aspherical Lens. G. Vitali. *Accad. Lincei, Atti.* 13. *pp.* 767–769, *May* 17, 1931.—The author referring to the optical problem discussed by Pacella [see Abstract 1873 (1931)] shows that Pacella's method leads to much simplified results when there is substituted for the plane face a spherical surface having its centre in the focus of the lens. J. J. S.

95. Stadimetric Telescopes, Especially with Internal Settings. M. Biot. *Ann. Soc. Sci. de Bruxelles*, 51. *pp.* 73–82, *Aug.* 8, 1931.—The stadimetric telescope is used to get the distance, D, of the vertical axis of the telescope from a distant point using a formula of the type $D = AL + B$, where A and B are constants of the telescope and L the length intercepted on two parallel wires of the reticule. The author obtains such a formula directly, and it can be used to calculate the optical constants of the telescope. The conditions to be satisfied by the optical constants of this telescope to get the maximum precision are discussed. R. S. R.

96. New Design of Microscope. A. S. Newman. *Phot. J.* 71. *pp.* 318–320, *Aug.*, 1931.—A description of various modifications in design introduced into a microscope built by the author. A. H.

97. Recent Developments in Microscopy. L. C. Martin. *Roy. Soc. Arts, J.* 79. *pp.* 871–885, *Aug.* 21, *and pp.* 887–896, *Aug.* 28, 1931.—The author describes first the general principles of the ultramicroscope with a reflecting dark ground illuminator. Siedentopf's method for obtaining visibility of small particles, Gerhardt's interference method for the measurement of very small globules, and the new uses of the polarisation microscope for the investigation of molecular structure in biology, physiology and geology are discussed. Finally the general design of the microscope stand, anastigmatic eyepieces and projection lenses, and the developments in the use of various optical materials and wave-lengths for increased resolving power are explained. R. S. R.

98. Aberration of Photographic Objectives. W. Linnik. *Zeits. f. Physik*, 71. 5–6. *pp.* 389–392, *Aug.* 29, 1931.—The arrangement described has a horizontal slit in front of the objective and another in the focal plane of the objective in an inclined direction. The diagram of spherical aberration for rays of different wave-lengths can be observed directly or photographed. For a good photographic objective of focal length about 21 cm. and aperture figure 1 : 4·5, the accuracy of the curve obtained is about 10 % of the total spherical aberration. R. S. R.

99. Isolation of Nuclei by Developers. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 30. *pp.* 65–68, *Aug.*, 1931.—Nucleus-isolation is the name given to a reaction of the latent image by which certain dyes markedly facilitate attack of the latent image by oxidative agencies, probably by colouring the AgBr and forcing the illuminated nuclei adsorbed at the surface of the grains from the sphere of action of the adsorption, thus removing their normal protection. This effect is produced, not only by dyes, but also by certain developers, such as metol and amidol. Other developers, *e.g.*, hydroquinone, adurol and pyrocatechol have an action differing little in degree from that of metol, provided that sulphuric acid is present in amount corresponding with that contained in the metol. Under the same conditions pyrogallol and resorcinol show a similar, though less pronounced, action. These results accord well with the conception, advanced by Sheppard and confirmed experimentally by Wulff and Seidl (*Zeits. f. wiss Phot.* 28. pp. 239–291, 1928), that the primary process in chemical development consists in adsorption of the developing compound by the AgBr. T. H. P.

100. Photography in the Infra-Red. R. Mecke. *Zeits. f. wiss. Phot.* 30. *pp.* 77–84, *Aug.*, 1931.—The difficulties of photographing the infra-red are discussed, and photographic studies of the atmospheric absorption bands between 7500 and 9500 Å. are described. The relative number of lines absorbed in each 100 Å. interval agree well with the numbers obtained with the thermopile. Observations with various gases indicate that the atmospheric lines are due wholly to water and oxygen. The high effective degree of dispersion attainable by the photographic method renders it of value for the study of rotation-vibration spectra, and the results of applying the method to the ammonia band at 7720 Å. are described; the structure observed closely resembles that of the band at 3 μ. H. F. G.

101. Photomicrography at 312 mμ. A. P. H. Trivelli and E. Lincke. *Zeits. f. wiss. Phot.* 30. *pp.* 85–87, *Aug.*, 1931.—The principal advantages of using the mercury-arc line at 312 mμ, in addition to the high resolution and the degree of selective absorption obtained, are the cheapness of the apparatus needed compared with that required for working at shorter wave-lengths and the fact that Canada balsam and other materials are transparent to this wave-length. H. F. G.

102. Desensitisation with Uranyl Formate and Potassium Ferrioxalate. E. Baur. *Zeits. f. wiss. Phot.* 30. *pp.* 88–94, *Aug.*, 1931.—The desensitising action of a solution of uranyl sulphate and formic acid conforms to the equation $v_1/v_0 = 1/(1 + b\mathrm{U})$, where v_1 and v_0 are the photochemical reaction velocities in presence and absence, respectively, of the uranyl ion, and U is the uranyl concentration. Experiments with a solution of uranyl sulphate and potassium iodide demonstrate quantitatively the establishment of a stationary state due to the reversed dark reaction. Allmand and Webb's observation, *viz.*, that the velocity of photolysis of potassium ferrioxalate is constant up to about 30 % decomposition, has been confirmed. The reaction proceeds without desensitisation of the reaction products, and the photolytic process thus takes place in the interior of the photosensitive complex. H. F. G.

103. Villard Effect. H. Arens and J. Eggert. *Zeits. f. wiss. Phot.* 30. *pp.* 121–126, *Aug.*, 1931.—The phenomena of Villard's effect [see Abstract 1222 (1898)]—that the latent image produced by an X-ray illumination is more or less abolished by a subsequent illumination with white light sufficiently faint—are coordinated by means of a solid diagram. A. D.

104. Solarisation. Part V. The Latent Image in the Region of Solarisation with Physical Development. H. Arens. *Zeits. f. wiss. Phot.* 30. 3–6. *pp.* 127–140, *Aug.* 1931.—Methods previously described [see Abstract 4178 (1931)] are extended to a study of solarisation in a special emulsion using physical development (*p*-phenylenediamine) after fixation; as before, the total latent (photolytic) silver, the number of development centres and the upper limit of their mean size, are estimated. To obtain an emulsion giving a manageable quantity of photolytic silver and at the same time susceptible to solarisation on physical development it was found necessary to prepare AgBr in the absence of gelatin and then to disperse it in the latter. The total photolytic silver increases progressively with exposure throughout the solarisation and second inversion regions, but the number of development centres declines after passing through a maximum. Solarisation is thus to be ascribed to regression in the number of centres rather than in the quantity of photolytic silver, as formerly suggested. The mean size of the development centres simultaneously increases, a fact observed directly and further supported by the increasing difficulty experienced in affecting the grains by thiosulphate or by photographic reducers, as exposure is increased. L. V. C.

105. Relative Masses of Photo-Silver. S. E. Sheppard. *Phot. J.* 71. *pp.* 313–317, *Aug.*, 1931. *Comm. No.* 459 *from the Kodak Research Lab. Phot. Indust.* 29. *pp.* 1089–1090, *Oct.* 7, *and pp.* 1114–1116, *Oct.* 14, 1931.—Calculations and arguments based on recent work indicate that the number of atoms of photo-silver formed per gm. of silver halide in latent image formation is too small to agree with previous " critical size " theories of nucleation. The suggestion is made that " aspect " or orientation of silver atoms to initiate a silver space lattice is a more essential function of sensitising specks than mere size. A. H.

106. Photographic Emulsion: After-Ripening. B. H. Carroll and D. Hubbard. *Bureau of Standards, J. of Research*, 7. *pp.* 219–259, *Aug.*, 1931.—A survey is made of the changes taking place in a photographic emulsion after it has been washed. It is found that this after-ripening is dependent on the extent to which sensitivity nuclei have been formed before washing, and the influence of temperature, and of bromide, chloride, and hydrogen-ion concentrations is predictable on the basis of chemical reactions forming sensitivity nuclei. A. H.

107. Reduction of Photographic Plate Graininess. F. E. Wright. *J.O.S.A.* 21. *pp.* 485–496, *Aug.*, 1931.—Descriptions are given, and relative advantages discussed, of a number of methods for decreasing the effects of plate graininess when spectral lines are being examined. The methods discussed are: (*a*) oscillation of the lines along their lengths (Linnik);

(*b*) use of a cylindrical lens placed above the objective with its axis normal to the lines (Anderson); (*c*) interposition of a piece of parallel-sided glass between the objective and the negative, so introducing astigmatism and coma; (*d*) reduction of the resolving power of the observing system (by means of slits) so that the image points along the line are no longer separated; (*e*) use of a Wollaston prism on the negative so as to produce two overlapping images of the lines; (*f*) viewing under dark ground illumination, sometimes in conjunction with one of the other methods. It is concluded that no one method is greatly superior to the others. For star images the only feasible method seems to be (*d*). A. H.

108. Etching Three-Colour Half-Tone. C. D. Hallam and R. S. Cox. *Phot. J.* 71. *pp.* 310–312; *Disc.*, 312, *Aug.*, 1931.—A method is described of correcting the tone values in three-colour etching by matching the colours of an original with the corresponding hues in a three-colour chart, thus giving the correct proportion for each printing colour required. The colour chart is produced from a scale of seven tones, solid black to white, and printed in standard three-colour inks. A. H.

109. Advances in Photo-Topography. O. Lacmann. *V.D.I.* 75. *pp.* 1047–1053, *Aug.* 15, 1931.—Details the advances made in the subject since the publication of a paper by P. Seliger [see Abstract 1166 (1929)]. The chief developments have been in instruments for mapping the course of aircraft in flight, and in cameras for taking aerial photographs for map-making. A number of the latter are described and illustrated in the paper. J. W. T. W.

110. Photoelectric Photometry. E. Gambetta. *Rev. d'Optique*, 10. *pp.* 297–324, *Aug.*, 1931.—Describes in some detail the various methods of using photoelectric cells for photometric measurements of different kinds. The so-called "direct" methods depend on the measurement of the current flowing through the cell as a result of the illumination of the kathode. The "indirect" methods include compensation circuits with or without amplification of the current to be measured. The compensating current may be supplied by another cell, by piezoelectric quartz or in other ways. Zero methods are more or less analogous to visual bench photometry, in that compensation is effected by altering the illumination on another cell until there is equality of the two photoelectric currents. The author then goes on to consider the application of photoelectric methods to spectrophotometry, to microphotometry, and to densitometry. In particular the photoelectric modification of the Yvon-Jobin spectrophotometer is described and illustrated. J. W. T. W.

111. Colour and Intensity of the Chemiluminescence of Solid Sodium. R. M. Bowie. *J.O.S.A.* 21. *pp.* 507–512, *Aug.*, 1931.—The fact that solid sodium reacts with the moisture in the air to produce a faint glow has been known for years. The colour of the light was said to be greenish and its intensity extremely low, although no careful measurements had been made. In this article a method is described for determining its intensity by means of a photoelectric cell. The determination of the spectrum of the light as obtained both by filters and spectrographically is also described. The intensity was found to vary from $3 \cdot 5$ to $10 \cdot 5 \times 10^{-7}$ lumen per sq. in. of sodium surface, while the spectrum was found to consist of a band between 5000 Å. and 5300 Å. with a maximum at about 5100 Å. AUTHOR.

112. Fluorescent Excitation of Mercury by the Resonance Frequency and by Lower Frequencies. (Lord) Rayleigh. *Roy. Soc., Proc.* 132. *pp.* 650–667, *Aug.* 1, 1931.—A continuation of previous work [see Abstract 594 (1930)]. Two types of fluorescence are distinguished—that due to the core of the resonance line and that due to the light of less frequency absorbed in the band which begins at the resonance line, called the wing effect. The core fluorescence is extinguished by a trace of hydrogen, while the wing effect persists with very large additions. In the region 2650 to 3000 a series of diffuse bands is found with the core excitation, while another series of bands is excited by the wing in the same region. The wing series in emission is enormously increased by superheating, but not the core series. It is considered probable that the core excitation is a process of collision with excited mercury atoms which are known to lose their energy by collision with hydrogen molecules. Wing excitation, on the other hand, is due to molecular absorption, though the subsequent processes are obscure. The excited molecules are not affected by collision with hydrogen. J. E.

113. Absorption Spectra of Metallic Derivatives of Benzoylcamphor. T. M. Lowry, H. Burgess, I. J. Faulkner and R. C. Traill. *Roy. Soc., Proc.* 132. *pp.* 387–397, *Aug.* 1, 1931.—With the exception of the derivatives of the alkali-metals, which behave as metallic salts, the metallic derivatives of benzoylcamphor behave as coordination-compounds. The absorption spectra of the following derivatives have been examined: $\mathrm{Li}^{\cdot}$, $\mathrm{Na}^{\cdot}$, $\mathrm{Be}^{\cdot\cdot}$, $\mathrm{Cu}^{\cdot\cdot}$, $\mathrm{Al}^{\cdot\cdot\cdot}$, $\mathrm{Cr}^{\cdot\cdot\cdot}$, $\mathrm{Fe}^{\cdot\cdot\cdot}$, $\mathrm{Co}^{\cdot\cdot\cdot}$, $\mathrm{Th}^{\cdot\cdot\cdot\cdot}$. The spectra of the first two compounds each include two maxima, at wave-lengths corresponding with those of the single maxima of the two forms of the parent-compound. These maxima are displaced in the beryllium derivative, and in the case of the remaining metals only one maximum lies within the range of experiment. The selective absorption of all these compounds is attributed to polar activation of the unsaturated system. The fact that the metallic derivatives reproduce, with more or less modification, the absorption bands of the two forms of the parent compound, indicates that the unsaturated system is not destroyed by coordination, although it may be modified by the presence of a metallic atom. For previous work see Abstract 360 (1925). H. H. Ho.

114. Absorption Band Spectra of Silver Bromide and Silver Iodide Vapours. B. A. Brice. *Phys. Rev.* 38. *pp.* 658–669, *Aug.* 15, 1931.—The absorption spectra of the vapours of AgBr and AgI are photographed under high dispersion, band systems and continuous spectra being observed for both molecules. A vibrational analysis is made in each case, and, whilst a rotational analysis is not feasible, it is thought that in both cases the electronic transition is ${}^1\Sigma \leftarrow {}^1\Sigma$. Heats of dissociation are calculated as 2·77 and 0·21 volts for the normal and excited states of AgBr; 3·02 and 0·10 volts for the corresponding states of AgI. The vibrational isotope effect is well shown by both molecules, AgBr exhibiting fourfold heads whilst AgI exhibits double heads—no evidence for an isotope of iodine being found. A. H.

115. Energy Levels of Gadolinium IV in the Crystal Lattice from the Ultra-Violet Absorption Spectra of Gadolinium Chloride and Bromide Hexahydrates. S. Freed and F. H. Spedding. *Phys. Rev.* 38. *pp.* 670–678, *Aug.* 15, 1931.—A study is made of the ultra-violet absorption spectra of crystals of $GdCl_3 . 6H_2O$, and $GdBr_3 . 6H_2O$ at room temperatures, and also at the temperature of liquid air. A number of electronic energy levels of the gadolinium ion are obtained. These levels are found to be decomposed by a magnetic field into doublets of enormous separations amounting to as much as 15 times the normal Larmor precession. In the absence of a magnetic field the intervals between the electronic levels are much smaller than might be expected for an ionic crystal of the rare earths. Small intervals and large magnetic separations in crystals lead to a " Paschen-Back effect " which is visualised as the incipient uncoupling of the positive ion from the lattice, and evidence is presented showing that uncoupling occurs more readily along certain of the crystal axes than others. A. H.

116. " Raies Ultimes " and Absorption Lines. A. T. Williams. *Comptes Rendus*, 193. *pp*. 358–360, *Aug*. 24, 1931.—It has been suggested by Bloch and by Meggers that the *raies ultimes* of an element should be found amongst the lines which show absorption. This suggestion is only verified in a few of the cases examined. In fact, the absorption lines are not all *raies ultimes*, and only a few of the latter are absorption lines. The explanation given is that the methods of excitation used for obtaining *raies ultimes* have not the " purity " of the method which is used for absorption spectra, in which only lines derived from the fundamental or near-by levels make their appearance. J. H. A.

117. Spectrum of the Kathode Glow in Nitrogen and Other Gases. K. G. Emeléus and Olive Hall. *Roy. Irish Acad., Proc.* 40. *pp*. 1–10, *June*, 1931.—The arc spectrum of nitrogen (NI), which is otherwise difficult to excite, appears in the light from the kathode glow of a low-voltage d.c. discharge from a cold kathode. Special tubes are described for exciting the spectrum in this way, and an explanation of the effect is based on the work of Kallmann and Rosen on the exchange of charge between positive ions and neutral particles. The explanation accounts for kathode glow spectra in a number of polyatomic gases and gas mixtures. F. S.

118. Excitation Conditions of the Argon Spectrum. O. Fischer and W. Hanle. *Zeits. f. wiss. Phot.* 30. *pp*. 141–146, *Aug*., 1931.—The spectrum was excited in twelve stages between 15 and 100 volts in a discharge tube provided with an oxide-kathode and three anodes. Photographs taken with a three-prism spectrograph show the lines which are excited at various stages, and that some decrease in intensity with increasing voltage. Spark lines first appear above 35 volts. F. S.

119. Mercury Band Spectrum. H. Hulubei. *Comptes Rendus*, 193. *pp*. 154–156, *July* 20, 1931.—Rayleigh has drawn attention to certain bands accompanying the resonance line 2536·52 Å. (*Nature*, 127. *p*. 125, *Jan*. 24, 1931). The author has observed similar bands in some spectrograms taken of a mercury-vapour lamp burning entirely under water. Two systems are noticeable: (1) When the lamp burned at 4–5 amperes, on plates over-exposed for the resonance line, were diffuse bands on both sides of the resonance line, extending from 2652 to 2482 Å. The intensities fall off rapidly, receding from the resonance line. (2) When the lamp burned at 2·4–2·8 amperes, and the exposure was not too long, the first system disappeared. A filter was used to cut down the resonance line; it consisted of mercury vapour at low pressure. The bands then visible

were sharp and clear, and Rayleigh's bands formed part. They extended from 2576 to 2528 Å. Other bands of a similar type have been observed accompanying other lines, *e.g.*, the group 2652·042, 2653·681, 2655·127 Å.
A. C. M.

120. Ultra-Violet Bands of Phosphorus Oxide. P. N. Ghosh and G. N. Ball. *Zeits. f. Physik*, 71. 5–6. *pp.* 362–370, *Aug.* 29, 1931.—The ultra-violet bands of PO are measured under high dispersion. They fall into a single system. The following values are obtained for the vibration constants of the molecule: $\omega_e' = 1391 \cdot 0$ cm.$^{-1}$, $x_e'\omega_e' = 7 \cdot 65$ cm.$^{-1}$, $\omega_e'' = 1230 \cdot 64$ cm.$^{-1}$, $x_e''\omega_e'' = 6 \cdot 52$ cm.$^{-1}$. The heat of dissociation calculated for the lower states is about 7·4 volts. The band system is attributed to a $^2\Sigma \rightarrow {}^2\Pi$ transition. C. B. A.

121. Vacuum Spark Spectra of Potassium and Calcium in the Region 100 Å. to 1100 Å. E. Ekefors. *Zeits. f. Physik*, 71. 1–2. *pp.* 53–88, *Aug.* 4, 1931.—A concave glass grating of 1 m. radius and with 1183 lines per mm. was used at a glancing angle of 5·6°. Full details of the technique of producing the spark are given, and the behaviour of the grating is discussed. Tables of wave-lengths and intensities for both K and Ca are given, and most of the lines are classified by the effect of self-induction in the spark circuit. F. S.

122. Hyperfine Structure of Sr, Ag, Mo, Cu and Au. S. Frisch. *Zeits. f. Physik*, 71. 1–2. *pp.* 89–92, *Aug.* 4, 1931.—In continuation of earlier researches [see Abstract 3091 (1931)] a search for hyperfine structure is extended to certain lines in the spectra of the elements Sr, Ag, Mo, Cu and Au. The lines λ4078 and λ4215 of SrII; λ3281 and λ3383 of AgI; and the lines λ3903, λ3864 and λ3798 of MoI are found to be simple, and it is therefore concluded that Sr, Ag and Mo have nuclear moments $I = 0$. The resonance lines λ3247 and λ3274 of Cu are found to have a doublet structure indicating a nuclear moment for Cu which is not very large. It is again stressed that nuclei containing even numbers of protons and electrons have no nuclear moment. J. E. K.

123. Spectral Purity Attainable for Monochromators in the Ultra-Violet. C. Leiss. *Zeits. f. Physik*, 71. 3–4. *pp.* 156–160, *Aug.* 15, 1931.—Instead of using two monochromators in series with one another to obtain high spectral purity, the author employs a preliminary resolver consisting of two convex quartz lenses and a slit, with a single monochromator. The two lenses are geared together, so that the distance of the first one from the slit is always the same as that of the second from the slit of the monochromator. The result is that if the apparatus is focussed so that light of any wave-length is refracted so as to form a parallel beam by the first lens, this beam falling on the second lens forms an image of the entrance slit on the monochromator slit. Light of other wave-lengths will not give a sharp image, and only a small percentage of it will enter the monochromator. This preparation of the entering light is found to give very satisfactory purity in the light coming from the monochromator. H. N. A.

124. Width of Spectral Lines Treated by the Correspondence Principle. L. Rosenfeld. *Zeits. f. Physik*, 71. 3–4. *pp.* 273–278, *Aug.* 15, 1931.—Expressions are obtained for the width of spectral lines and intensities by a method of Heisenberg which involves the correspon-

dence principle, and gives more accurate results than Dirac's method of quantising the field of radiation [see Abstract 4095 (1931)]. The power of Heisenberg's method is illustrated by considering a particular case.
H. L. B.

125. Line Absorption and Brightness of Spectral Lines. W. Schütz. *Zeits. f. Physik,* 71. 5–6. *pp.* 301–305, *Aug.* 29, 1931.—Continuing a previous work on the relation between the total absorption and the number of centres and thickness of the layer, the author, making the same assumption that the absorption coefficient is determined from the distribution of dispersion and the Doppler effect, deals with the connection between the line absorption and the brightness of spectral lines. The result is that there is a characteristic maximum for the line absorption in a certain region of brightness. This maximum explains certain peculiarities in previous observations by Gouy and Senftleben. H. N. A.

126. Intensity Summation Rules and Perturbation Effects in Complex Spectra. G. R. Harrison and M. H. Johnson, Jr. *Phys. Rev.* 38. *pp.* 757–778, *Aug.* 15, 1931.—After reviewing the problem of line intensities in complex spectra, a new J-group sum rule is derived. A J-group is defined as the totality of lines arising from transitions between all terms from one electron configuration having a given value J_1 of the inner quantum number and all terms corresponding to a given value J_2; it maintains its identity for all couplings. Verification is found in some cases calculated theoretically, and comparison is made with Dorgelo's measurements in neon. F. S.

127. New Raman Bands of Water. E. Segrè. *Accad. Lincei, Atti,* 13. *pp.* 929–931, *June* 21, 1931.—The scattered spectrum of the mercury 2537 Å. line has been examined in the immediate neighbourhood of the unmodified line, by the device of using mercury vapour as an absorbing screen. A new band with a separation of 140 cm.$^{-1}$ was found, intense on the lower frequency side, but hardly perceptible on the " anti-Stokes " side. It is suggested that the band is due to oscillations in the polymers of H_2O. This is in accordance with the smallness of the separation, since the mass concerned would be large and the bond a weak one. It was also found that raising the temperature, which tends to reduce the number of associated molecules, decreased the intensity of the line. J. H. A.

128. Polarisation of Raman Lines from Calcite. J. Cabannes and (Miss) D. Osborne. *Comptes Rendus,* 193. *pp.* 156–158, *July* 20, 1931.—Cabannes [see Abstracts 2463 (1929) and 655 (1930)] made observations on the polarisation of Raman lines scattered by quartz and by calcite. The former agreed with observations by Menzies [see Abstracts 655 and 1039 (1930)], but the latter were questioned by Schaefer, Matossi and Aderhold [see Abstract 604 (1930)]. As a result of a re-investigation, the authors conclude that they were correct in stating that of the three lines 1087, 712 and 1437 cm.$^{-1}$, the two last behaved similarly, and differently from the first with regard to polarisation. They agree with Schaefer that 1437 is not to be regarded as a harmonic of 712. The frequencies of the lines are given to a greater accuracy than before, and their behaviour in respect of polarisation is tabulated. No present theory accounts for the states of polarisation observed. A. C. M.

129. Raman Effect with a Sodium Nitrate Crystal. J. Cabannes and E. Canals. *Comptes Rendus,* 193. *pp.* 289–290, *Aug.* 3, 1931.—The

Raman lines of sodium nitrate, at 103·1, 190·1, 730·4, 1074·2, 1391·4 and 1678·5 cm.$^{-1}$, are recorded; the lines for calcite, which has the same crystalline structure, lie at 157·4, 283·8, 712·1, 1087·3, 1436·6 and 1752·0 cm.$^{-1}$. Of the lines at 720 and 1400 cm.$^{-1}$, which correspond with vibrations in a plane normal to the ternary axis, the former is the more intense for calcium carbonate and the latter for sodium nitrate. The polarisation of the Raman lines has been studied; the results indicate that the internal oscillations are almost completely polarised, although not in the same direction. H. F. G.

130. Influence of Electrical Fields on the Lines of the Ultra-Violet Neon Spectrum (NeI and NeII). N. Ryde. *Zeits. f. Physik*, 71. 1–2. *pp.* 124–136, *Aug.* 4, 1931.—It has been found by the author that with regard to the higher members of the principal series of the arc spectrum (NeI) the results can be dealt with in relation to the hydrogen difference of the upper terms involved. A large number of lines belonging to the first spark spectrum (NeII) appear on the spectrograms, displaced towards longer wave-lengths. They are divided into two groups, with the approximate limits 3180 to 2890 Å. and 2645 to 2550 Å. At the short wave-length side of these lines combination lines are found, which are not affected by the field, or displaced towards shorter wave-lengths. The principal lines are explained as lines of the Bergman series. As a result certain Bergman and super-Bergman terms have been calculated and a contribution has been made to the analysis of the complicated spectrum. H. N. A.

131. Dependence of Intensity and Line Sharpness of the Stark Effect Components of $H\gamma$ on Field Strength. R. Gebauer and H. R. v. Traubenberg. *Zeits. f. Physik*, 71. 5–6. *pp.* 291–298, *Aug.* 29, 1931.—A new method is applied to the determination of the existence limits of the red $\pi 18$ Stark effect component of $H\gamma$ and to the measurement of the line-widths of the red and violet components. In agreement with earlier measurements, the critical field strength for the $\pi 18$ red component of $H\gamma$ is found to be about 720,000 volts/cm. The half value width of the red components appears to increase with increasing field strengths, but that of the violet components is little influenced. The dependence of the frequency of $\pi 18$ red component on field strength is in good agreement with Schrödinger's theory. J. E. K.

132. Ionisation of Air by X-Rays of Varying Hardness and Degrees of Homogeneity in Cylindrical Chambers 2 to 70 cm. in Diameter. H. Küstner. *Ann. d. Physik.* 10. 5. *pp.* 616–648, *July* 29, 1931.—These experiments lead the author to conclude that the accuracy that has hitherto been obtained in absolute measurements of ionisation of the air by X-rays has been overrated, and that it requires great care and the avoidance of many sources of error if the absolute value is to be correct even within ± 1·5 %. The relative values of the ionisations caused by different homogeneous beams of X-rays can probably be estimated rather more accurately, to about several tenths of 1 %. Sources of error are discussed in detail. H. L. B.

133. Ionisation of the Inert Gases by X-Rays. O. Gaertner. *Ann. d. Physik*, 10. 7. *pp.* 825–832, *Aug.* 18, 1931.—By the method previously described [see Abstract 205 (1930)] the following values per pair of ions were found: for the filtered radiation of a copper anode (1·27 Å.

mean wave-length), neon 43·2 ± 8, argon 28·8 ± 1, krypton 32·4 ± 3, xenon 47·5 (saturation). With argon the measurements were extended to shorter wave-lengths: 28·6 volts (0·688 Å.), 28·0 volts (0·468 Å.), 29·3 volts (0·345 Å.). As subsidiary result is mentioned the considerable lowering of the spark tension in neon which, under the conditions of the experiment, occurred through X-radiation. J. J. S.

134. Partial Absorption of X-Rays. M. Bötzkes. *Zeits. f. Physik*, 71. 3–4. *pp.* 151–155, *Aug.* 15, 1931.—The phenomenon has been recently described by B. B. Ray [see Abstract 1561 (1931)]. Certain modified lines were found in addition to the primary lines, after passing through an absorber. The author has calculated the most favourable thickness for producing this result. The probability of such excitation of subsidiary lines in carbon, using $CuK\alpha_1$ radiation, is shown to be at least 10^3 times smaller than that of a normal photoelectric absorption process. None of the author's experiments led to a positive result. [See also Abstract 76 (1932).] H. N. A.

135. Total Reflection of X-Rays. H. Kiessig. *Ann. d. Physik*, 10. 6. *pp.* 715–768, *Aug.* 11, 1931.—An apparatus is described which is used for the investigation of the geometrical conditions (photographically) and of the intensities (ionisation chamber) during the total reflection of X-rays from nickel-on-glass mirrors. The preparation of the mirrors is described, and their optical properties are investigated by photometric methods. The intensities of reflected wave-lengths on either side of the K-edge show general agreement with theory. Such deviations as occur are near the limit of total reflection, and can be attributed to irregularities in the mirrors. With stronger absorption, more serious deviations from theory are observed. In particular, the measured reflection is too high at small reflection angles. It is assumed that a transition region of variable thickness exists on the outer nickel surface. Investigation of the relation of reflection-intensity to thickness of nickel film brought to light two new phenomena. After the limiting angle of total reflection is passed, the beam reflected from the lower nickel surface is reflected with increasing intensity, so that a thin mirror reflects more strongly than a thick one. Still smaller thicknesses do not allow of total reflection, and the reflected intensity is less than normal. Since the curve of total reflection agrees with the Fresnel formula, the refractive index can be calculated, and the dispersion curve in the neighbourhood of the K-edge is given. It is in general agreement with the theoretical curve of Kallman and Mark, while any deviations are similar to those observed by Larsson. It is concluded that crystalline material is unsuitable for exact measurement of dispersion, on account of uncertainty in the density and of the nature of the surfaces. [See also Abstract 3466 (1930) and following Abstract.] C. B. A.

136. Interference of X-Rays in Thin Films. H. Kiessig. *Ann. d. Physik*, 10. 7. *pp.* 769–788, *Aug.* 18, 1931.—In the course of investigations of total reflection of X-rays at nickel mirrors [see preceding Abstract] it was observed that after the limiting angle of total reflection was passed, rotation of the mirror gave rise to maxima and minima of intensity. This is attributed to thin-film interference, reflection of X-rays also occurring at the second (denser medium) surface. The film thickness and refractive indices can be determined. The interference curve is calculated from the Fresnel formula for a given case. It agrees satisfactorily with observation. The optical formulæ are thus applicable to X-rays. The interference obtained with the thickest films for the $NiK\alpha_1$ line allow of the calculation of refractive index to about 1 % accuracy. C. B. A.

137. Scattering of X-Rays by Gases. Y. H. Woo. *Nat. Acad. Sci., Proc.* 17. *pp.* 467–475, *Aug.*, 1931.—A general theory of the intensity of total scattering of X-rays by the molecules of a polyatomic gas is developed on the assumption that only the coherent scattered radiations from the different atoms will interfere with each other, while the incoherent radiations will be simply added up. The results of the theory are in good accord with Barrett's observations. Compton's correction-factor, though somewhat arbitrary, is supported by observation. A. D.

138. X-Ray Scattering by Diatomic Gases. E. O. Wollan. *Nat. Acad. Sci., Proc.* 17. *pp.* 475–479, *Aug.*, 1931.—On the whole, there is a satisfactory agreement between Woo's calculations and the writer's scattering results. Points of difference noted. A. D.

139. Diffuse Scattering of X-Rays from Sylvine. G. G. Harvey. *Phys. Rev.* 38. *pp.* 593–603, *Aug.* 15, 1931.—By means of the formulæ recently obtained by Compton for monatomic gases and by Jauncey and Harvey for simple cubic crystals, S values can be calculated from the observed intensities of the diffused scattering. The formula for crystals is only valid for the case where the crystal consists of atoms of only one kind. Up to the present time the only crystal for which S values were known was rock-salt, but this is a crystal containing two kinds of atoms. Sylvine, KCl, consists of only one kind of atom, for the K and the Cl are both argon-like. In the present research S values have been obtained for sylvine at room temperatures. The results agree remarkably with those from argon. A. D.

140. Effect of Temperature on the Intensity of X-Rays Diffusely Scattered from Rock-Salt. W. D. Claus. *Phys. Rev.* 38. *pp.* 604–617, *Aug.* 15, 1931.—The effect of temperature on this diffused scattering has been predicted by Debye, by Waller (modifying Debye) and by Jauncey and Harvey. The author has verified that there is such an effect in rock-salt; and he finds that the Debye theory is precluded, that the Waller–Debye theory holds good at low temperatures, and the Jauncey–Harvey theory at high temperatures. A. D.

141. Theory of the Double X-Ray Spectrometer and Determination of the Shape of AgL, MoK and CuK Lines. R. C. Spencer. *Phys. Rev.* 38. *pp.* 618–641, *Aug.* 15, 1931.—An X-ray which comes from a point-source and is reflected from a fixed and a moving crystal must pass through a focal point fixed in space and also through a second focal point moving with the crystal. These focal points are the best positions for an ionisation chamber window or slit. A universal type of mounting, based on this, is described. The author gives a study of the shape of the AgL, MoK and CuK lines, worked out with the above instrument. A. D.

142. Input Limits of X-Ray Generators. A. Müller. *Roy. Soc., Proc.* 132. *pp.* 646–649, *Aug.* 1, 1931.—A continuation of previous work [see Abstract 1075 (1930)] relating to the input limit of X-ray generators. The results of calculations dealing with a line focus on a stationary and on a moving target are given. Experimental evidence is given that the theory gives the correct order of magnitude for the input limit. W. V. M.

RADIOACTIVITY.

143. Mass and Energy. L. Meitner. *V.D.I.* 75. *pp.* 977–980, *Aug.* 1, 1931.—A discourse in which it is shown from consideration of the behaviour of electron and proton rays (artificial disintegration) that energy can be changed into mass, and mass into energy, and that consequently mass is only a special form of energy. J. J. S.

144. Distribution of Radioactive Materials in the Atmosphere. J. Priebsch. *Phys. Zeits.* 32. *pp.* 622–629, *Aug.* 15, 1931.—The author has found an error in W. Schmidt's calculations with regard to the distribution of radioactive materials in the atmosphere, in which the latter assumed that the exchange increased with the height at a certain rate. The author has also worked out the distribution assuming a different value for the amount of increase of the exchange with height. Figures are given for the distribution of radon at different heights, according to the different assumptions made. H. N. A.

145. Measurement of the Activity of Radioactive Substances with the Torsion Balance. J. Zahradniček. *Phys. Zeits.* 32. *pp.* 630–634, *Aug.* 15, 1931.—The beam of the torsion balance consisted of a strip of thin sheet aluminium, loaded at the ends with small lead spheres. It was hung so that its large surfaces were vertical in a long brass box, in which was a window closed by aluminium foil, through which α- and β-rays could pass and fall on the side of the beam near one end. Experiments were made using radium and radon, and it was found that forces were produced which caused deflections in the beam. These could be measured, by means of a mirror attached to the beam, either telescopically or photographically. In the case of radon the relation between the deflections and the time could be studied, the distance from the window being kept constant. With radium the effect of altering the distance of the preparation from the window, and of introducing sheets of absorbing material between the preparation and the window, could be determined. H. N. A.

146. Use of Thyratrons for High-Speed Automatic Counting of Physical Phenomena. C. E. Wynn-Williams. *Roy. Soc., Proc.* 132. *pp.* 295–310, *July* 2, 1931.—Several circuits are described whereby thyratron valves can be used for very high-speed automatic counting of voltage impulses set up by physical phenomena. An instance is the automatic counting of α-particles. While the ultimate mechanical counting is carried out by means of a comparatively slowly operating mechanism, the circuits employed are such that the counting speed can be made independent of, and greater than, that of the counting mechanism. This is done by distributing the task of counting among a number of thyratrons interconnected in such a way that there is always a thyratron available for recording an impulse, however rapidly impulses follow one another. Good experimental results have been obtained. Two impulses separated by as little as 0·002 sec. were separately recorded. A suggestion is made of a high-speed "meter" with "dials", consisting of thyratrons, and containing no moving parts of any description. J. J. S.

147. Ionisation in the Tracks of Single α-Rays. K. Diebner. *Ann. d. Physik,* 10. 8. *pp.* 947–982, *Aug.* 24, 1931.—The relation between the degree of saturation of the ionisation of single α-particles, and the angle between the incident ray and the electrical field, was investigated in air and CO_2. A vacuum duant electrometer was used in the measurements of the ions. The experimental results were compared with the theory of Jaffé, which gives the relation between the above angle, the diffusion, the recombination coefficient and the saturation characteristics; there was complete agreement. The constant K_0 in Geiger's relation $K = K_0 R^{\frac{2}{3}}$ was found to have the value $6 \cdot 26 \times 10^4$ for air, and $8 \cdot 30 \times 10^4$ for CO_2. From this the value of Z, the number of atoms disintegrating per gm. of radium per sec., is calculated as $3 \cdot 71 \times 10^{10}$. For the α-ray velocities employed 1 % more ions are produced in CO_2 than in air. H. N. A.

148. β-Transformation. B. M. Sen. *Phil. Mag.* 12. *pp.* 439–441, *Aug.*, 1931.—The chance of an electron being emitted from the nucleus is discussed mathematically, and radioactive properties shown to be a direct consequence of increasing atomic number. C. A. S.

149. Study of γ-Rays by Means of Magnetic Spectra. J. d'Espine. *Ann. de Physique*, 16. *pp.* 5–70, *July-Aug.*, 1931.—A connected account of previously published work of the author and others, describing the methods used, the magnetic velocity spectra of RaB + C, RaE, MsTh2 and ThB + C [see Abstracts 1105, 2110, 2531 (1925) and 3149 (1927)], and the retardation of such rays by matter [see Abstract 1598 (1926) and 1958 (1928)]; followed by a discussion of the various theories of the production of these spectra. The conclusions arrived at are that the line spectra are due to conversion of γ-rays in the various electronic orbits in accordance with Einstein's photoelectric law, and the continuous background to emission of disintegration electrons from the nucleus at varying speeds, combined with quantum degradation of the γ-radiation by the Compton effect. C. A. S.

150. Origin of γ-Rays. (Lord) Rutherford and C. D. Ellis. *Roy. Soc., Proc.* 132. *pp.* 667–688, *Aug.* 1, 1931.—The authors consider the ratio of the number of quanta of γ-radiation to the number of long-range α-particles from the level of origin assigned to the radiation transition. Suggestions are made which differ from those put forward by Gamow, and also by Gurney and Gordon, to explain the disintegration process, and finally the hypothesis is suggested that many of the different excited states of the radium C′ nucleus, whose existence is shown by the long-range α-particles, and the γ-rays, arise from the excitation of one, two, three or more α-particles to the same higher level. A full list of the γ-rays, including the latest values found by Ellis, is analysed into four groups, in one of which it is found that the difference in energies between a number of lines is about $0 \cdot 4 \times 10^{-5}$ volt or a multiple of this number—this is within the limits of the probable experimental error; similar results are found for other groups. On the basis of the above hypothesis the energies of the γ-rays should be expressed by a formula of the type $E = pE_1 - qE_2$, where p is the number of particles making simultaneous transitions from the upper state to the ground state; the integer q may be expected to reach high values, since it will depend both on p and on the number of particles in the upper state, E_1 is the ordinary difference in energy of the two states, and E_2 is mainly determined by the interaction energy between the particles (probably small compared to E_1). It appears that two higher levels are in fact involved, and a detailed scheme is satisfactorily worked out, accounting for all the γ-rays. H. N. A.

HEAT.

151. Problems in Heat Conduction. G. Green. *Phil. Mag.* 12. *pp.* 233–255, *Aug.*, 1931. *Supplement.*—A theoretical discussion on a general method of investigation of solutions of all problems involving the transmission of an effect by wave motion throughout a limited medium. The effect of boundary conditions is determined, and all the well-known heat solutions are readily expressed in integral form by the present method. The solution of problems by means of wave trains introduces a unification throughout mathematical physics, and in the special applications of the present case the application of the method to heat problems involving the effects due to continuous sources has yet to be investigated. Mathematical throughout. S. G. B.

152. Copper-Constantan Thermocouple Calibration below 0° C. R. Wiebe and M. J. Brevoort. *U.S. Bureau of Mines Report, No.* 3077. *Rev. Sci. Instruments,* 2. *pp.* 450–457, *Aug.*, 1931.—Copper-constantan thermocouples were calibrated against a Pt-resistance thermometer. The tabulated results show that the deviation curve in connection with Adams' or Southard and Andrews' data from 0° to – 193° C. for Cu-constantan thermocouples calibrated at the sublimation point of CO_2(– 78°·5 C.) and the boiling point of O_2(– 182°·97 C.) can be represented by: deviation $= ae + be^2$ with an accuracy of 0°·05 C., where e is the e.m.f. of the thermocouple and a and b are constants. The authors state that each thermocouple must be calibrated separately to obtain this accuracy. R. S. R.

153. Precision Thermostat for Temperatures from – 25° to 200° C. J. A. Beattie. *Rev. Sci. Instruments,* 2. *pp.* 458–465, *Aug.*, 1931.—Details of the construction and performance of the thermostat are given. The bath has a large heat capacity and three stirrers 120° apart. Flat electric heaters are used in the bath fluid. For temperatures up to 150°–200° C. mineral seal oil is used in the bath, for 150°–300° C. a heavy cylinder oil, and for higher temperatures a mixture of $LiNO_3$, $NaNO_3$ and KNO_3. Automatic regulation for periods of 8 hr. from 30° to 480° C. gives a variation of $\pm$ 0·001° C. R. S. R.

154. Laboratory Furnaces and Temperature Regulators. P. Chevenard. *Rev. de Mét.* 28. *pp.* 453–468, *Aug.*, 1931.—Furnaces consisting of silica or porcelain tubes wound with nichrome, platinum and its alloys, tungsten and molybdenum are described, attention being confined to those suitable for use at temperatures not higher than the melting point of iron. Suitable grading of the pitch of the windings is given, to ensure uniformity of temperature along the furnace tube. A clockwork-driven rheostat is described for obtaining a linear rate of temperature-rise of the furnace, with time. In the second part, two temperature regulators are described, one utilising the expansion of a special alloy (Pyros), and the other aiming at constancy of power supply. The former switches extra resistance into the circuit if the temperature rises, and may be relied on for constancy to two or three degrees at 1000° C. The paper contains, incidentally, a description of some work on viscous flow of metals. J. H. A.

155. New Formulæ for Calculating Specific Heat, Expansion Coefficient and Vapour Pressure of Water. H. Hofbauer. *Pont. Accad. Sci., N. Lincei, Atti*, 84. *pp.* 581–586, *June* 21, 1931. *In German.*—Further consideration of the formula given [see Abstract 3144 (1931)] with its extension to temperatures outside the range for which it was originally proposed. J. H. A.

156. Thermal Expansion and Atomic Heat of Solid Mercury. L. G. Carpenter and F. H. Oakley. *Phil. Mag.* 12. *pp.* 511–522, *Aug.*, 1931.—An accurate method of obtaining the coefficient of expansion of solid mercury is described. The atomic heat C_v at constant volume can be obtained from the equation: $C_p - C_v = \alpha^2VT/K$: T is the absolute temperature, V the atomic volume, K the compressibility, α the coefficient of expansion, C_p the atomic heat at constant pressure. A curve shows that C_p remains practically constant between 200° and 220° Absolute, then rises suddenly, and subsequently becomes horizontal at the melting point with a value 6·13. That this exceeds 3R may be due to anharmonic atomic vibrations. H. M. B.

157. Formation of Condensation Nuclei by Metals at Ordinary Temperature. D. Pacini. *Pont. Accad. N. Lincei, Atti*, 84. *pp.* 632–639, *June* 21, 1931.—The possibility of the formation of nuclei upon which water is able to condense from a supersaturated atmosphere has been studied for a number of metals and amalgams at room-temperature, The results with magnesium confirm fully the positive result of Aitken, but with zinc and amalgamated zinc the results are somewhat uncertain, and for all the other metals examined they are definitely negative. H. F. G.

158. Vapour Pressure of Hydrogen Selenide and Telluride. N. O. Stein. *Chem. Soc., J. pp.* 2134–2138, *Aug.*, 1931.—The vapour pressures of the two compounds were measured by the static method, using a mercury manometer and with a pentane thermometer for the temperatures. The solid and the liquid were studied for both substances, and the results are given in the form $\log_{10} p = -A/T + B$, where T is absolute temperature and A, B are given below.

	A	B		A	B
H_2Se (liquid)	1030	6·27	H_2Te (liquid)	1005	5·53
„ (solid)	1380	7·96	„ (solid)	1220	6·39

The observations on which these equations are based cover the range 173° to 238° K. J. H. A.

159. Molecular Magnitude and Phase Distribution. Part II. J. N. Brönsted and E. Warming. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 343–352, *Aug.*, 1931.—The distribution of a colloidal substance between two liquid phases which under ordinary conditions is practically one-sided [see Abstract 4243 (1931)] becomes measurable in the neighbourhood of the critical temperature of mixing. The theoretical considerations are verified for the distribution of colloidal arsenic trisulphide and chromium hydroxide in water-butyl alcohol-ethyl alcohol mixtures. For small differences of temperature, the logarithm of the distribution ratio is proportional to the square root of the difference between the actual temperature and the critical temperature. T. H. P.

SOUND.

160. Estimation of Heights Reached by Air-Waves which Descend in Zones of Abnormal Audibility. F. J. W. Whipple. *Gerlands Beitr. z. Geophys.* 31. 1–3. *pp.* 158–168, 1931. *In English.*—Gutenberg has recently given [see Abstract 568 (1931)] an apparently simple procedure for dealing with the results of observations of the air-waves from explosions. It is here pointed out that Gutenberg's method must be unreliable, since the actual times of transmission of the air-waves from the source to the observing station are ignored. It is then shown how this defect in Gutenberg's method can be remedied. A. W.

161. Influence of Atmospheric Conditions upon the Audibility of Sound Signals. B. R. Hubbard. *Acoustical Soc. of America, J.* 3. *Pt.* 1. *pp.* 111–125, *July,* 1931.—A summary of the causes of the irregularity noticed in the audibility of fog signals. The observations and theories of various writers are quoted and the results of the test of fog-horns at Boston, U.S.A., carried out in Sept., 1930, are given. Striking instances are given of the unreliability of loudness observations for ascertaining distance, *e.g.*, a fog signal which is audible for eight miles under favourable conditions may be just audible under other conditions of atmosphere at a mile or less. The effect of "silent zones," due to the bending down of the sound waves when temperature decreases normally upwards, is considered. There are now few phenomena of fog signalling which cannot be explained upon generally recognised principles. The atmosphere is seldom homogeneous and aberrations in the audibility may be due to any or all of three causes—wind, temperature and humidity. The work of all investigators points to the first of these causes as the most important in causing inefficiency. The observed effects are illustrated by diagrams and tables summarising the results obtained. J. J. S.

162. Effect of Humidity upon Absorption of Sound in a Room. Determination of Coefficients of Absorption. V. O. Knudsen. *Acoustical Soc. of America, J.* 3. *Pt.* 1. *pp.* 126–138, *July,* 1931.—The results of the author's experiments confirm the general findings of Sabine [see Abstract 3112 (1929)] and Meyer [see Abstract 4069 (1930)] and throw further light on points of theoretical and practical interest. The author has taken advantage of the special atmospheric conditions at Los Angeles, California, where the investigations were carried out in the two test chambers of the acoustical laboratory of the University. Each of these rooms is enclosed by two separate walls of 12 in. thickness of reinforced concrete, and the floors rest upon a 6 in. fill of sand and a 2 in. slab of cork, being thus insulated from the effects of external vibration,sound and heat. Owing to the small temperature changes throughout the seasons of the year the temperature in the room was never lower than 20° C. and never higher than 22° C. and usually differed by only two- or three-tenths of a degree from 21° C. The relative humidity, on the other hand, followed closely the changes of the outside humidity, and changes from 14 % to 70 % within a period of 48 hours were not infrequently noted. Thus the effects of relative humidity on sound absorption could easily be investigated within a wide range without resorting to artificial aids. Humidities above 70 % were readily obtained by evaporation of water in the room. Reverberation times were measured (1) by obtaining oscillographs of the decay of sound, (2) by measuring the times for specified amounts of decay by means of a microphone pick-up, a five stage amplifier and a relay-controlled chronograph, and (3) by making reverberation measurements with the ear and a recording chronograph. In the oscillograph and relay methods " warble " tones were used having a band width of 200 ∼ and a frequency of warble of 5 to 7 ∼ per sec. The results are given in photographs of oscillograms, curves and tables and cannot be stated in a short abstract, but in general the experiments indicate that the absorption of sound in the air is an important factor which must be taken into consideration in problems in sound signalling and in architectural acoustics. J. J. S.

163. Sound Insulation of Materials and Buildings. J. F. Cellerier. *Soc. Franç. Élect., Bull.* 1. *pp.* 684–704, *July*, 1931.—A study of the applications of electricity to test the nature and effect of sounds in rooms and halls especially with a view to providing insulation from sound. Arrangements were made for the emission of pure notes and for their reception after passage through various materials. For emission a tuning fork with electrical adjuncts was used as oscillator, and an amplifier, a selective filter and an electrodynamic diffuser were also employed. For receiving the transmitted sound a microphone, an amplifier and various measuring instruments were utilised. It has been found so far that bodies but little porous are better sound insulators than porous bodies of the same material. Variety in the composition of partitions by using sheets of different materials modifies the transmission of sound very sensibly compared with equal thickness of one material. Certain straws chopped up or pounded give good results. The best insulating materials, however, lose most of their value if they enclose metallic parts, especially when these face the exterior. J. J. S.

164. Recent Progress in Acoustics. F. Trendelenburg. *Zeits. f. Hochfrequenztechn.* 37. *pp.* 105–112, *March;* 235–237, *June, and* 38. *pp.* 33–40, *July;* 80–84, *Aug.;* 115–118, *Sept.;* 153–160, *Oct.; and pp.* 189–195, *Nov.*, 1931.—A summary of recent progress in acoustics, including the analysis of sounds, the design of sound emitters and musical instruments, the ear and language, the acoustics of buildings and sound-recording. Special attention is devoted to the design of loud-speakers. E. E. F. d'A.

165. Physical Characteristics of Speech and Music. H. Fletcher. *Rev. Modern Physics*, 3. *pp.* 258–279, *April*, 1931. *Bell System Techn. J.* 10. *pp.* 349–373, *July*, 1931. *Acoustical Soc. of America, J.* 3. *No.* 2. *Pt.* 2. [25 *pp.*], *Oct.*, 1931. *Supplement.*—The paper discusses chiefly the pressure changes in sound waves undistorted by reflection. In speech there are a series of comparatively steady states of vibration joined either by silences or transitions in pitch. The characteristic pitch of the vowels is examined and limits assessed for these. In the case of the sounds f, th, sh and s, the frequencies are respectively 4000, 4500, 3700 and 5500. The apparatus used in measuring acoustical power is described. Average conversational speech power is 10 microwatts, or, if silent intervals are excluded, 15 microwatts. Taking the powers of a large number of speakers, about

7 % will use less than $\frac{1}{18}$ of the average power, while about 4 % will use powers from 4 to 8 times the average. Distinctions are made between the mean, phonetic and peak speech powers, and the components carrying conversational speech vary from 4000 to 5000 microwatts down to $\frac{1}{20}$ microwatt. For an extremely loud shout, the maximum power may rise almost to 1 watt. The pitch range necessary for transmitting men's and women's speech is from 90 to 10,000 ∼ per sec. Information is also given from papers already published [see Abstract 4254 (1931)]. G. E. A.

166. Curves of the Vowels. A. Stefanini. *N. Cimento,* 8. *pp.* 213–216, *June,* 1931.—The problem of the vowels, though continually being investigated, has found no solution free from objection. The author calls attention to the character of damped vibrations shown by the curves of some vowels and considers that it is probable that not only the period but also the mode of damping may be characteristic of each vowel. When it is sought by applying Fourier's theorem to determine the harmonics that accompany the fundamental note the complication presents itself that, whereas the theorem supposes that the sinusoidal curves representing the partial notes are of constant amplitude, it may be that such curves represent damped vibrations as Scripture has observed. Photographs of oscillograms are reproduced in the paper which show that the oscillogram of the German vowel *e*, obtained by Ardenne by the new Braun's tube, is of the same character as the vowel *a* of Gradenigo. Ardenne observes that in the oscillogram the 16th harmonic of the fundamental may be recognised, but does not mention the damping which the oscillations show. The work of other investigators is also discussed. J. J. S.

167. Acoustic Resonator Interferometer. Part I. The Acoustic System and its Equivalent Electric Network. J. C. Hubbard. *Phys. Rev.* 38. *pp.* 1011–1019, *Sept.* 1, 1931.—The steady state of motion of a fluid between two infinite plane parallel boundaries is found for the case in which one of the boundaries is given a prescribed periodic motion normal to its surface, the other boundary being infinitely rigid or being assigned a coefficient of reflection. The excess pressure at any point in the fluid is found, being of particular interest at the boundary of the source where it has a term in phase with the velocity of the source and one in phase with its displacement. These terms pass through cyclical values as the distance between the source and reflector is increased, the first passing through sharp maxima, the second changing rapidly from negative to positive values at reflector distances of an integral number of half wave-lengths in the fluid. Application is made to the case where the source is the surface of a piezoelectric plate maintained in forced vibration. The equivalent electric network of the plate and coupled column is found to be the same as that for the plate alone, with modified resistance and capacity coefficients, making possible consideration of the theory of the acoustic resonator interferometer in conjunction with driving and measuring circuits. AUTHOR.

168. Propagation of Longitudinal Waves in Cylindrical Rods. R. Ruedy. *Canad. J. of Research,* 5. *pp.* 149–155, *Aug.,* 1931.—The solution of the velocity equation obtained by Pochhammer on the basis of the mathematical theory of elasticity is determined for the propagation of longitudinal waves of any frequency in a long solid circular cylinder of any diameter. For a given frequency a large number of solutions may be obtained, but when the condition is imposed that for low frequencies the velocity must gradually assume the value found by experiment, a single value is obtained for each frequency. The velocity decreases with increasing frequency, so that, for a cylinder of finite length, the resonance frequencies come closer and closer together. It is also necessary to take into account, however, that in a solid rod longitudinal waves are accompanied by radial vibrations of the particles, and that a cylindrical rod has, regardless of its length, a series of natural frequencies for radial waves, so that for wave-lengths comparable with the diameter of the tube a coupled system of oscillations is set up. The resonant frequencies of such a system depend on the degree of coupling. AUTHOR.

169. Vibrations of Membranes and Plates. R. C. Colwell. *Phil. Mag.* 12. *pp.* 320–328, *Aug.*, 1931. *Supplement.*—The equations of motion for a stretched membrane are usually applied to a membrane fixed along its edge. The author shows how they may be applied to cases where the edges have one degree of freedom, a condition which is approximately fulfilled in the Chladni plate. The positions of nodal lines for such a membrane are worked out by the method, and compared with the nodal lines on a Chladni plate actuated by a valve-oscillator. The two sets of figures shown in the paper exhibit some similarity. The improvement of the experimental method results in the observation of some new sand-figures. J. P. A.

170. Theory of the Clarinet. P. Das. *Indian Journ. Phys.* 6. *pp.* 225–232, *Aug.*, 1931.—A mathematical treatment of the acoustics of the clarinet taking into account the coupling between the reed and the air column. The reed vibrates practically in the same phase with the change of pressure in the mouthpiece, opening itself so as to admit air into the tube when the pressure is large and shutting up at low pressure. When the reed is drawn in, its effective vibrating length is shortened, since a part of it at the root comes in contact with the mouthpiece, while it vibrates more freely during compression. Taking these factors into account an explanation can be given of the production of the twelfth instead of the octave on overblowing and of the presence of weak second and fourth and relatively strong seventh, eighth, ninth and tenth harmonics. W. H. GE.

171. Speed of Propagation of Musical Sounds. R. de la Boulaye and G. Balme. *Comptes Rendus*, 193. *pp.* 317–318, *Aug.* 10, 1931.—A completion of the work in which the late T. Vautier [see Abstracts 1946 (1930) and 1328 (1931)] was engaged. The speed of propagation of pizzicato notes from a double-bass fiddle and a 'cello along the Lyons conduit was measured, and notes of frequency 41·0 travel at 343·18 m./s.; when the frequency is increased to 649·4 the speed increases to 343·31 m./s., whilst the calculated speed for both in open air is constant at 343·34 m./s. This reduces to 330·73 at 0° C. The speed of an explosion wave in the duct was equal to that for the note of lowest frequency, *viz.*, 343·18. G. E. A.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

172. Electrostatic Machine of 300,000 Volts with a Single Plate. H. Chaumat. *Soc. Franç. Élect., Bull.* 1. *pp.* 673–683, *July,* 1931.—A description is given of an electrostatic machine which, with one disc of 46 cm. dia., attains a tension of 300,000 volts and a power which is about 30 times that of an ordinary Wimshurst machine. The principle of the Faraday cylinder is utilised, high insulation is obtained by use of mica and a velocity of 1600 r.p.m. is employed. J. J. S.

173. H.T. Electrostatic Machines. F. Luscia. *Elettrotecnica,* 18. *pp.* 530–531, *Aug.* 5, 1931.—After a study and examination of a large number of well-known types of electrostatic machines the author has produced a model of a machine for which he claims a number of advantages. The usual discs are replaced by concentric cylinders, the outer one being fixed and the inner one rotating. The machine is very simple mechanically, has a large inducing surface, is capable of high speeds and can produce very high tensions without the necessity of putting several machines in cascade. L. B. F.

174. Law of Charging of a Suspended Particle. C. Trage. *Ann. d. Physik,* 10. 7. *pp.* 833–845, *Aug.* 18, 1931.—The charge produced on a particle floating in an electrical field is partly due to ions which move along the lines of force to the particle, and partly to the thermal movements of the ions. The author has devised a method of investigating the process in which the spherical particle is replaced by a 4μ Wollaston wire, stretched parallel to a straight wire at a high negative potential (3000 volts), placed in the axis of an earthed metal cylinder. In the final apparatus the high-potential wire was surrounded by a concentric cylinder of wire gauze, which separated it from the Wollaston wire. This obviated the difficulty due to electrical wind from the central wire. The theory of Deutsch predicted charges higher than those observed, while that of Arendt and Kallmann could be made to agree with measurements by making use of a suitable constant of integration. The value of this constant makes it probable that the undisturbed ionic density is brought by turbulence in the gas very near to the surface of the " particle." H. N. A.

175. Capacity of the Quadrant Electrometer. G. Nadjakoff. *Comptes Rendus,* 193. *pp.* 356–358, *Aug.* 24, 1931.—Describes an experimental method of measuring the true capacity of the insulated system, and also the effective capacity when connected up. J. H. A.

176. E.M.F. between Two Metals in Relative Motion. J. B. Seth, B. Gulati and S. Singh. *Phil. Mag.* 12. *pp.* 409–429, *Aug.,* 1931. —In 1928 Lafay [see Abstract 1386 (1928)] found that when against the rim of a metal disc rotating at a known speed another metal was pressed an e.m.f. was developed which he gave as proportional to the relative speed of the two rubbing surfaces and independent of the pressure between them. The authors have repeated and extended Lafay's experiments and have obtained much higher e.m.f.s than those got by Lafay, and have examined a large number of metals pressed against a rotating steel disc moving at high speeds. Between silver and steel an e.m.f. of 123 mV was obtained, between Cu and steel 82 mV and between Al and steel 730 mV, the latter being the highest observed. The authors ascribe these effects to voltaic contact e.m.f.s. The e.m.f. observed appeared independent of pressure at the surfaces within certain limits of pressure but when the pressure was considerably raised the effect rapidly decreased and finally disappeared. When the e.m.f. exists there is no actual contact between the two metals but a fine layer of air separates them. The order of the metals when arranged according to the e.m.f. developed is generally that of the Volta contact potential series, but there are important exceptions which may be due to the particular treatment of some of the metals in the authors' experiments. J. J. S.

177. Properties of Atomic Layers. P. Lukirsky, A. Sosina, S. Wekschinsky and T. Zarewa. *Zeits. f. Physik*, 71. 5–6. *pp*. 306–324, *Aug*. 29, 1931.—The contact potential difference between an electrode and a thin metallic layer, deposited upon it in a vacuum, was determined. The presence of the layer altered the exit work of electrons from the electrode, which formed part of a triode. With monomolecular layers of barium and thorium the exit work of the surface is less than for thick layers, the full value being reached for bimolecular layers. The alteration is gradual from zero deposition up to bimolecular thickness. The effect of high temperature on layers of different thickness was observed. H. N. A.

178. Electrical Phenomena in Crystallisation. A. Tschermak. *Zeits. f. Krist.* 79. 5–6. *pp*. 465–494, *Aug*., 1931.—An account of experiments with supersaturated solutions or melts of sodium acetate trihydrate. To bring about solidification the addition of a bud crystal of the substance was required, and neither of the solids, dihydrate, monohydrate nor either of the anhydrates of sodium acetate would start the solidification. The solidification was started at one end of a tube containing the melt, and it was found that a wave of potential variation proceeded along the tube in connection with the change of state. Thus crystallisation is shown to be accompanied not only by the liberation of thermal energy, but also of electrical energy. A somewhat extended boundary phase of the crystal magma is found to be positively charged with respect to the liquid. The phenomena were registered photographically. H. N. A.

179. Frictional Electric Charges upon the Surfaces of Single Metal Crystals. P. A. Mainstone. *Phil. Mag*. 12. *pp*. 535–538, *Aug*., 1931.—Previous experiments [see Abstract 1539 (1930)] were made by the author on the frictional charges produced by very light rubbing upon the surfaces of metals under varying gas pressure. The present paper describes similar measurements made with single crystals of Al and Cu. The experiments do not reveal any marked differences between the triboelectric effects upon the various faces of a single metal crystal, or between the polycrystalline and single crystal surfaces. The difference between etched and polished surfaces was pronounced in the case of Cu, but not in the case of Al. J. J. S.

180. Constancy of Dielectric Constants at Extremely High Field Intensities. A. Güntherschulze and H. Betz. *Zeits. f. Physik*, 71. 1–2. *pp*. 106–123, *Aug*. 4, 1931.—The authors have made use of the oxide layers formed in electrolytic valves, with which very high field intensities can be reached, and the capacities can be accurately measured. Field intensities up to 12 million volts per cm. were obtained. With layers of Al_2O_3, Sb_2O_4, Bi_2O_3 and ZrO_2 the dielectric constant was found to be independent of the field intensity up to the highest values employed. With Ta_2O_5 there was a change in capacity of about 10 % when the field intensity was altered from small values up to 12 million volts per cm.; while the capacity with WO_2 was increased to 2·5 times its original value when the field intensity was reduced from the maximum to a minimum value. Observations were made with an oscillograph which confirmed these results. The optical behaviour of the layers does not indicate an actual change in the dielectric constant, so that the real meaning of the phenomena observed is not altogether clear. H. N. A.

181. Dielectric Coefficients of Gases. Part I. Rare Gases and Hydrogen. H. E. Watson, G. G. Rao and K. L. Ramaswamy. *Roy. Soc., Proc.* 132. *pp.* 569–585, *Aug.* 1, 1931.—In continuation of previous work by Watson [see Abstract 1389 (1928)] the dielectric constants ϵ, of He, Ne, A, Kr, Xe and H_2 have been measured at 25° C. and at $-$ 190° C. or $-$ 79° C. and compared with that of CO_2. The following mean values of $(\epsilon - 1) \times 10^6$ have been derived at the respective temperatures 25° C. and 0° C. and 760 mm. pressure: He, 25°, 66·7, 65·4; 0°, 72·8, 71·3; Ne, 25°, 122·9, 123·3; 0°, 134·0, 134·6; A, 25°, 504·4, 506·0, 510·3; 0°, 550·4, 552·0, 556·7; Kr, 25°, 768, 769; 0°, 838, 839; Xe, 25°, 1238, 1242; 0°, 1351, 1355; H_2, 25°, 251·8, 251·5; 0°, 274·9, 274·6; CO_2, 25°, 904·0, 986·8. None of the gases except argon has an electric moment which is detectable by the method employed. The upper limit for krypton and argon is $0{\cdot}05 \times 10^{-18}$; for argon, the value of the moment is $0{\cdot}03 \times 10^{-18}$, but this is probably a spurious result. For the other gases the moment is not more than $0{\cdot}015 \times 10^{-18}$. An approximate method of determining condenser distortion with pressure is described. J. S. G. T.

182. Electric Moment and Molecular Structure. Part V. Polymethylene Bromides. C. P. Smyth and S. E. Kamerling. *Am. Chem. Soc., J.* 53. *pp.* 2988–2998, *Aug.*, 1931.—The dielectric constants and densities of heptane solutions of dibromides with two, three, five and ten C atoms between the Br atoms have been measured over a range of temperature, and the results used to calculate the electric moments of the molecules. For data respecting the diethyl esters of dicarboxylic acids and for the glycols [see Abstract 3546 (1931)]. The moment of ethylene bromide is found to increase with rising temperature in accordance with theoretical predictions. The moments of methyl and ethyl bromide are used to calculate the moments which might be expected in the molecules. The observed values are lowered by proximity of the two bromide dipoles, which also gives rise to the temperature variation of the moment. In decamethylene bromide the two dipoles are so far apart that the observed and calculated moments agree satisfactorily and the moment shows no variation with temperature. Rotation around the C—C bonds probably causes some bending of the carbon chain, but there is no evidence of pronounced bending of the supposedly rod-like structures of the long chains, even in the external electric fields used in the measurement of the dielectric constants. H. H. Ho.

183. Temperature Variation of the Electric Moment of Ethylene Chloride. C. T. Zahn. *Phys. Rev.* 38. *pp.* 521–527, *Aug.* 1, 1931.—Observations are made on the vapour of ethylene chloride over a temperature range from 32° to 270° C. with considerable changes of pressure at each temperature. Results deviate considerably from the Debye theory. It seems necessary to assume that the electric moment varies with temperature as suggested by Eucken and Meyer. In the observed temperature interval, the electric moment increases with the temperature from $1 \cdot 1$ to $1 \cdot 5 \times 10^{-18}$ e.s.u.; whereas the value calculated by Meyer for truly free rotation is $2 \cdot 4 \times 10^{-18}$. This agrees with the predictions of Eucken and Meyer. It may be necessary to take into consideration the quantum theory rather than the classical theory of Meyer. H. M. B.

184. Lightning Investigation as Applied to the Aeroplane. A. O. Austin. *Monthly Weather Rev.* 59. *pp.* 259–264, *July*, 1931.—Hazards from lightning are divided into those (*a*) causing electrical or physical shock affecting pilot and passengers and (*b*) which damage the plane or aircraft. For (*a*) the following were considered, (1) direct hit, (2) path for the discharge between conductors, (3) shock from induced charge, (4) sudden change in air pressure, (5) severe sound or pressure waves, (6) currents induced in the body by an electromagnetic field and, (7) effect of intense light upon the pilot. For (*b*) consideration was given to (1) ignition of combustible material of the plane, (2) ignition of explosive gases, (3) weakening or destruction of metal or other parts due to current discharge, (4) breakdown of insulation in the ignition system, (5) back fire or pre-ignition, (6) damage to instruments, (7) damage to rotating parts due to current discharge, and (8) sudden change in pressure on adjacent surfaces. Tests were made on models to determine how these effects may be minimised or avoided. R. S. R.

185. Atmospheric Electricity. C. S. Dorchester and L. W. Butler. *Science*, 74. *pp.* 155–157, *Aug.* 7, 1931.—Measurements of the air earth current over a specially wired plot in Iowa confirmed in fine weather the direction found by C. T. R. Wilson, but the value 5×10^{-10} ampere is much smaller. In wet weather the current, 5×10^{-9} ampere, is also much smaller than Wilson's value, but in most cases the direction is the same as for fine weather. The results of measurements for two near thunderstorms confirm those of Schonland and Craig. R. S. R.

186. Solar Component of Cosmic Radiation. V. F. Hess and W. S. Pforte. *Zeits. f. Physik*, 71. 3–4. *pp.* 171–178, *Aug.* 15, 1931.—New measurements of the hard ultra-radiation by means of Hoffman's high pressure apparatus give further strong support to the hypothesis of the existence of a solar component of cosmic radiation. The daily course of the ionisation shows, with all-round shielding by a screen of 10 cm. of lead, a distinct maximum at 12 noon local time. The maximum contribution of the solar component is about $0 \cdot 005$ of the total radiation. From the course of the daily curve the absorption coefficient of the solar component is shown to be about $\mu = 5 \times 10^{-4}$ cm.$^{-1}$ (H_2O). Based on this value the yearly periodic and the geographical dependence of the solar component is worked out. Tables of the observations and the curves referred to are given in the paper. J. J. S.

187. Aurora and Cosmic Rays. A. Dauvillier. *Comptes Rendus*, 193. *pp.* 348–350, *Aug.* 17, 1931.—It is suggested that the permanent circular corona of radius 1000 km. surrounding the magnetic pole at a height of 200 km., assumed by Nordenskiold on the grounds of his observations north of Siberia in 1878–9, indicates a faint permanent aurora due to the movement of the earth in the electronic flux from the sun, being the geodesics of solar electrons circling in the earth's magnetic field. The energy of such electrons would be 15 × 10^9 volts, or sufficient to account for the cosmic rays. The theory is discussed with reference to auroral draperies, the production of ozone, the concentration of auroral phenomena at the poles, earth currents, the variation in the height of the conducting layer and the line 5577 in the night sky, with all of which it is held to be consistent. C. A. S.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

188. Connection Between Ferromagnetism and Conductivity. H. Sachse. *Zeits. f. Physik*, 70. 7–8. *pp.* 539–547, *July* 14, 1931.—For non-metallic ferromagnetic substances the connections between ferromagnetism and electrical conductivity are not certainly observable. The distinction in conductivity found by Ghosh [see Abstract 3591 (1931)] between the ferromagnetic and paramagnetic form of Fe_2O_3 is to be imputed to secondary causes. Both forms indeed show a difference of conductivity which, however, actually is small. Other differences occur, *e.g.*, the ferromagnetic form is brown, the paramagnetic brick-red. Ghosh's statement of the amount of difference of conductivity is certainly much too great. Traces of water may easily remain in the iron oxide. The conductivity of the material is partially electrolytic in nature. Investigations of some other non-metallic ferromagnetic substances, especially in the neighbourhood of the Curie point, show no noteworthy deviations from the normal change of conductivity with temperature. The substances examined were NiO, Fe_2O_3, PbO, Fe_2O_3 and Cr_5O_9. J. J. S.

189. Part Played by Protons in Electrical Conduction in Metals. Part II. Measurements of Resistance. A. Coehn and H. Jürgens. *Zeits. f. Physik*, 71. 3–4. *pp.* 179–204, *Aug.* 15, 1931.—In the present paper it is shown that when a current flows through a wire, one point of which is charged with H, the H is unevenly distributed on both sides of this point, and that this can be proved by the greater increase of resistance on the side which has become richer in H. A wandering of H in the direction of the field can be observed in Pd-Ag alloys up to 20 % of silver. Both with pure Pd and with the Pd-Ag alloy it was found possible to " press in " a certain amount of hydrogen above the saturation state by electrolysis with increased potential. This hydrogen escaped spontaneously as soon as the potential was removed. In this overcharging with hydrogen the resistance dropped suddenly. [For Part I see 3519 (1930).] H. N. A.

190. Theory of Metals. Part I. Eigenvalues and Eigenfunctions of the Linear Atomic Chain. H. Bethe. *Zeits. f. Physik*, 71, 3–4. *pp.* 205–226, *Aug.* 15, 1931.—A method is given for calculating the eigenfunctions of zero approximation and the eigenvalues of first approximation (in the sense of the approximation process of London and Heitler) for a " unidimensional metal." This is formed of a linear chain of numerous atoms, each of which, in addition to closed shells has one *s*-electron with spin. In addition to the " spin waves " of Bloch eigenfunctions exist for which the spin pointing in one direction endeavours as far as possible to fix itself on closely neighbouring atoms. These eigenfunctions appear to be important in the theory of ferromagnetism.

H. N. A.

191. Electrical Conductivity and Structure of Thin Sheets of Metal. Part I. W. Reinders and L. Hamburger. *Ann. d. Physik*, 10. 6. *pp*. 649–669, *Aug*. 11, 1931. **Parts II and III. L. Hamburger.** *Ibid.* 10. 7. *pp*. 789–824, *Aug*. 18, *and* 10. 8. *pp*. 905–926, *Aug*. 24, 1931.—The structure of thin sheets of a refractory metal condensed at low temperature in a high vacuum from rarefied vapour was deduced by means of probability calculations. On the hypothesis that the atoms on collision with the wall of the enclosure or with the already formed condensate remain piled up just at the point of contact and that they only accumulate at right angles to the wall it follows that if at the wall, on which in a closed monatomic layer there is room for n atoms, An atoms are sublimed, the portion of the wall where the layer has a b-fold thickness is given by the formula: $x = \mathrm{A}^b(0\cdot368)^{\mathrm{A}}/b!$ Thin layers of tungsten condensed at low temperature on glass or quartz have a structure which chiefly corresponds to this probability distribution. Other metals under similar conditions have on the whole this structure. In thicker layers and on rise of temperature there occurs a disgrouping of the atoms which leads to the arrangement seen in crystals. This disgrouping takes place the more easily the greater the thickness of the layer and the less refractory the metal concerned. The high specific resistance of thin metallic layers, formed and measured at low temperature must be ascribed chiefly to the abnormally great distance apart of the atoms. The strong negative temperature coefficient of the resistance in thin layers of a metal like tungsten is explained by an increase of thermal mobility on rise of temperature. The connection between the specific resistance of very thin layers of metal of amorphous and porous nature and the thickness of the layer is discussed in the second paper, and in the third paper the effect of rise of temperature on metallic layers condensed at a low temperature is considered. It is found that while the conductivity and the thickness of various metal sheets formed in a high vacuum at low temperature are closely related this holds true also in many cases for high temperatures. The chief phenomena concerning the electrical conductivity of thin metal layers are expressed in a schematic diagram and are indicated approximately by the formula $\log \sigma = \rho \log \mathrm{D} + \mathrm{K}$ where σ = specific resistance, D = thickness of layer and to ρ and K physical meaning can be attributed.

J. J. S.

192. Measurement of H.F. Resistance of Wires. K. Kreielsheimer. *Zeits. f. Physik*, 71. 3–4. *pp*. 260–272, *Aug*. 15, 1931.—The difficulties of accurate measurement in consequence of the skin effect of the resistance of conductors traversed by h.f. currents are referred to and also the methods employed to overcome them. A description is given of the method adopted by the author and the results of the measurements made when the Wheatstone bridge was used up to a wave-length of 45 m. for the measurement of the resistance and the self-induction of manganin wires of various diameters. The a.c. bridge was with the intermediate introduction of a transformer to d.c. changed over into a null indicator in a d.c. bridge. By means of the new method of arrangement a high degree of accuracy of measurement was attained. The arrangement serves for measurement of the h.f. resistance of iron wires with the object of the determination of the magnetic permeability. J. J. S.

193. Hall Effect in Liquid Metals. J. Kikoin and I. Fakidow. *Zeits. f. Physik*, 71. 5–6. *pp*. 393–402, *Aug*. 29, 1931.—The question of the existence of the Hall effect in liquid metals is dealt with and it is shown that a survey of the investigations which have been published proves that the opinion which various authors have expressed that the Hall effect in liquid metals in general does not exist is both theoretically and experimentally quite unfounded. The question has been tested in the case of Hg and of K-Na alloys and it is shown that with K-Na alloys the effect actually appears and is of the order of magnitude which is theoretically to be expected and with normal sign (−). With Hg the effect is so small as to be unmeasurable. J. J. S.

194. Change of Resistance of Nickel in a Magnetic Field. H. H. Potter. *Roy. Soc., Proc.* 132. *pp*. 560–569, *Aug*. 1, 1931.—The change of resistance of a nickel wire has been measured in both transverse and longitudinal fields up to 7000 gauss for the temperature range −183° to 460° C. Near the Curie point (357° C.) the change of resistance is independent of the direction of the field and is found to vary with field and temperature in a manner analogous to the variation of the magneto-caloric effect. Since the latter is a direct measure of the energy of magnetisation, the changes of resistance must be, as suggested by Gerlach and Schneiderhan [see Abstract 985 (1931)], proportional to the changes in magnetic energy. This is shown to be the case both in the ferromagnetic state and in the quasi-paramagnetic state above the Curie point. J. S. G. T.

195. Theory of Current Rectifiers. C. Wagner. *Phys. Zeits.* 32. *pp*. 641–645, *Aug*. 15, 1931.—Electronic conduction in cuprous compounds, and its increase due to excess in the amount of the chemically electronegative element, are explained by the resulting presence of Cu^{++} ions, which cause defects in the normal Cu^{+} lattice, and make the transport of electrons possible. This idea is applied to produce a theory of the copper-copper-oxide rectifier, which gives a qualitative and semi-quantitative explanation of its action. It seems possible to apply the same idea to other systems containing solid semi-conductors, both rectifiers and detectors. In the general case not only ions of the electropositive element with higher valency, but ions with lower valency should be considered; also anomalously charged ions of the electronegative element concerned, and free electrons. It should be possible to gain additional information by means of measurements of capacity of the semi-conducting layer. The use of layers of cuprous oxide on copper as photoelectric cells is mentioned. H. N. A.

196. Ballistic and Perfect Balances in Bridges. A. T. Starr. *Phil. Mag*. 12. *pp*. 265–280, *Aug*., 1931. *Supplement*.—A simple method for finding the conditions for perfect or ballistic balance in bridges is given. The operational calculus is used to prove the method by which much work may be saved. The use of inverse networks in forming a bridge with a perfect balance is given, and two types of bridges—the equal ratio bridge, and the inverse network bridge—are discussed. J. J. S.

197. Splash Negative Figures and Side-Branches of Positive Discharge Figures on Photographic Plates. T. Terada. *Kyoto Coll. Sci., Mem*. 14. *pp*. 131–149, *July*, 1931. *In English*.—Discharge-figures were taken on photographic plates on which a gas-blast was thrown. The blast shows a remarkable effect on the negative figure, while it produces hardly any appreciable change in the form of the positive figure. The " splash negative figure " obtained with the blast is probably mainly due to an irregular distribution of gas-pressure produced by the blast. Some experiments as to the formation of the side-branches of the positive figures have been carried out. The results show that the " thorns " produced at the successive new electrodes on the stems have a close relation to the formation of the side-branches, and they are explained by Yoshida's theory [see Abstract 1007 (1917)]. The fact that the spreading-out of the positive figure is greater than that of the negative is experimentally proved to be due to the difference in horizontal intensity of the field at the edges of the positive and negative stems. AUTHOR.

198. Striated Discharges. L. G. H. Huxley. *Phil. Mag.* 12. *pp.* 380–384, *Aug.*, 1931. *Supplement.*—Measurements were made to determine the electric force in the positive columns of d.c. discharges in neon. The values obtained were 5·4, 4·6, 3 and 2 volts/cm. for pressures of 5, 1, 0·6 and 0·4 mm. respectively. These results are discussed in their bearing on the theory of the striated discharge. A. W.

199. Aston Dark Space. A. Güntherschulze and F. Keller. *Zeits. f. Physik*, 71. 3–4. *pp.* 238–245, *Aug.* 15, 1931.—An investigation was made of the thickness of the Aston dark space as dependent on the gas pressure. A photographic method was used for He and direct observation for Ne, A, H_2, N_2 and O_2. In all cases, with the exception of O_2, in which the Aston dark space is so small that definite conclusions as to its behaviour cannot be drawn, the results gave direct proportionality between the thickness of the dark space and the reciprocal of the pressure. The Aston dark space therefore follows the laws of similarity just like the kathodic parts of the glow discharge. The value of measurements of the thickness of the Aston dark space lies in the fact that, together with the excitation potential of the gas in question, they give the field strength immediately in front of the kathode for small kathode potential falls. From the observations on He it can be deduced that the behaviour of the field strength, as observed by Brose in the Hittorf dark space for high field strengths of some thousands of volts, is also applicable to He and small kathode potential falls, the field strength after reaching a maximum towards the kathode decreasing again. The same appears to hold good for the other gases dealt with. A. W.

200. New Phenomenon in the Dark Space of the Glow Discharge. A. Güntherschulze and F. Keller. *Zeits. f. Physik*, 71. 3–4. *pp.* 246–249, *Aug.* 15, 1931.—A description is given of the appearance of an extremely bright and sharply defined green zone observed immediately following the first very narrow dark zone at the kathode of a glow discharge in helium, using a kathode containing magnesium and potentials above 600 volts. The thickness of this green zone is very small, being only about an eighth of that of the Aston dark space. A. W.

201. Electron Emission from Langmuir Probes and from the Kathode of the Glow Discharge through Gases. M. L. E. Oliphant. *Roy. Soc., Proc.* 132. *pp.* 631–645, *Aug.* 1, 1931.—This paper presents the results of measurements made to determine the positive ion and electron currents at the surface of a simplified form of kathode, a negatively charged Langmuir probe in the positive column of an arc discharge through various gases. The theory of the cold probe developed originally by Langmuir and Mott-Smith assumes that the electron emission is zero, but evidence of electron emission is given both by observation of the current-voltage characteristic of such a probe and by measurement of the heating effect of the positive ions. A compensation method was used for measuring the ratio of positive ion current to electron current at the surface of the probe. The characteristics of small cylindrical probes are discussed and it is shown that the space potential differs very little from the floating potential of the probe. It was found that i_p, the fraction of the current carried by positive ions, is constant for negative probe potentials from 40 to 600 volts. The values of i_p vary from 0·85 in argon to 0·52 in neon, corresponding to electron emissions of 21 to 80 % of the positive-ion current. Possible sources of error are discussed, and the application to the theory of the glow discharge is pointed out. A. W.

202. Influence of Electric Discharges on Kathodic Secondary Emission. T. I. Câmpan. *Phys. Zeits.* 32. *pp.* 593–597, *Aug.* 1, 1931. *Paper read before the Deut. Phys. Gesell., Jena, May and June,* 1931.—An investigation was made of the secondary emission from a platinum kathode due to positive ions and of the effect of electric discharges, with normal kathode fall, in the gases H_2, N_2 and O_2. From the curves showing the variation of the secondary emission with the velocity of the positive ions it can be shown that the adsorbed gas layers at the kathode due to the discharge possess a high secondary emission, but that surface effects of small secondary emission characteristic of each gas also exist. These characteristic secondary emissions are found at ionic velocities up to 400 volts. The results are discussed in their bearing on theories of the electric discharge. A. W.

203. Kathode Disintegration in Mercury Vapour. K. Meyer and A. Güntherschulze. *Zeits. f. Physik,* 71. 5–6. *pp.* 279–290, *Aug.* 29, 1931.—A continuation of the authors' previous work on kathode sputtering [see Abstract 3807 (1930)]. Instead of using light gases, a heavy vapour was used at very low pressure of the order of 0·005 mm. Sixteen different metals were sputtered at voltages up to 10,000. In nine of the metals the amount disintegrated was proportional to the atomic weight, one mercury ion bringing about the evaporation of one atom of the substance. The nine metals were Al, Si, Mn, Fe, Ni, Zr, Mo, Ta and W. In other metals, such as Cr and Pt, the amount disintegrated increases with the liability of the metal to amalgamation. E. E. F. d'A.

204. Determination of the Impedance of Hot-Kathode Discharge Tubes. W. F. Westendorp. *Rev. Sci. Instruments,* 2. *pp.* 437–446, *Aug.,* 1931.—By means of a superposed a.c. the negative resistance of hot-kathode neon and mercury d.c. arcs was measured and found to follow closely the slope of the static characteristic of the neon arc and to be widely different in the case of the mercury arc. At the same time the reactance for the ripple current in the arc was determined. This reactance is explained on the basis of a time lag in the concentration of metastable atoms; from the phase shift the order of magnitude of the lifetime of the metastable atoms is computed and the result is in agreement with calculations made by others. AUTHOR.

205. Breadth of the Doppler Band in the Unhomogeneous Canal Ray. H. Straub. *Ann. d. Physik,* 10. 6. *pp.* 670–672, *Aug.* 11, 1931.—The author continues a former paper [see Abstract 3814 (1930)], in

which it is recorded that the magnitude of the coherence lengths of the lines H6563 and Hg5461 in the fading unhomogeneous canal ray are smaller than in the Geissler tube. As explanation for this deviation the great width of the shifted line of the Doppler effect and the consequent unhomogeneity of the velocity of the illuminating particles is given. To this it might be objected that the distribution of velocity of the illuminating particles might depend on the pressure in the observation chamber and hence influence the homogeneity. To test this observations were made with a Steinheil three-prism spectrograph and photographs of the observed lines and photometer curves are given. These show that the breadth of the moved lines is practically independent of the pressure.
J. J. S.

206. Townsend Discharges in Dense Clouds in the Presence of Space Charges. W. Deutsch. *Ann. d. Physik*, 10. 7. *pp*. 847–867, *Aug*. 18, 1931.—A value is obtained for the change in the starting-potential caused by the influence of a space charge. The phenomena are investigated which present themselves in a cylindrical corona field when a gas containing particles in suspension passes at a steady rate through a discharge tube. It is shown that the loss of the particles in the flowing gas is accompanied by the same phenomena *spatially* as occur in the stationary gas *successively* in time. The bearing of these phenomena on the electrical " cleaning up " of gases is discussed. H. L. B.

207. Mobility of Na^+ Ions in N_2 and H_2 as a Function of Time. L. B. Loeb. *Phys. Rev*. 38. *pp*. 549–571, *Aug*. 1, 1931.—The mobility of Na^+ ions from a Kunsman source are measured in H_2 and N_2, using gases of considerable purity and time intervals ranging from 10^{-5} to 10^{-1} sec. The Rutherford a.c. method is used both with sinusoidal and square waveform oscillations. After correction for temperature and pressure, the absolute mobility constants are correct to 10 %. The results indicate three distinct classes of ions in H_2 and probably three in N_2. The fastest ion in H_2, presumably Na^+, exists only for 10^{-4} sec. and has a mobility of 17·5 cm./sec. per volt/cm. In N_2 the initial mobility is 3·75 cm./sec. per volt/cm. In both cases the change to an intermediate ion, probably a single molecular addition, is abrupt, and to the normal ion gradual. Comparing the initial mobilities with those obtained from Langevin's theory, in which dielectric polarisation is taken as an inverse fifth-power type, the theoretical values are 20 to 30 % too low. This result is gratifyingly small, and should prove valuable in extending theory. H. M. B.

208. Mobility of Monomolecular Ions. H. R. Hassé and W. R. Cook. *Phil. Mag*. 12. *pp*. 554–566, *Aug*., 1931.—First the integral occurring in the formula for the diffusion of molecules under attractive and repulsive forces is calculated by a method given in a former paper [see Abstract 443 (1930)]. Secondly, on the classical electrostatic theory, the above-mentioned formula is applied to the calculation of the mobilities of monomolecular ions and may be regarded as a continuation of former work [see Abstract 1093 (1926)]. Finally, a new aspect of the problem of the mobility of ions is considered in which a transference of charge from the ion to the atom occurs as proved experimentally. In all cases this results in a decrease of mobility, considerable if there is a transference of charge at each collision. H. M. B.

209. Natural Period of Vibration of Ionised Gases. J. Placinteanu. *Comptes Rendus*, 193. *pp*. 286–288, *Aug*. 3, 1931.—The object of the author is to show that the hypothesis put forward by J. J. Thomson in a recent paper is equivalent to the consideration of a double layer, made up of ion-electron systems, and vibrating as a closed whole. It is then found that either using an elementary calculation, or by employing Coulomb's law, or finally by simply considering the gas as an electrical conductor, the result obtained is J. J. Thomson's formula $\nu = (e^2\mathrm{N}/\pi m)^{\frac{1}{2}}$. With J. Jonescu's mechanical model the results obtained are different, Thomson's formula has to be corrected by a constant factor as there is the possibility of disionisation and a second frequency appears. H. N. A.

210. Conductivity of Gases in Uniform Electric Fields. S. P. McCallum and F. L. Jones. *Phil. Mag.* 12. *pp.* 384–392, *Aug.*, 1931. *Supplement.*—Various theories of electrical discharges have recently been elaborated which are based on hypotheses of doubtful validity. They include several laws relating to the loss of energy of electrons in collisions with atoms and to the properties of metastable atoms. Attention is drawn to objections which have already been raised to these theories, and the results to which they lead are compared with the results of experiments on purified monatomic gases which have recently been made at the Electrical Laboratory, Oxford. It is concluded that there are fundamental errors in the hypotheses that have been adopted. It is impossible to admit that there is a high probability of electrons losing their energies in collisions with atoms when their energies are sufficient to excite radiation or ionise the gas. It is also shown that the theory of ionisation in its simplest form, as given originally by Townsend, affords a rational explanation of the conductivity of uniform luminous columns in discharges through gases. [See also Abstract 352 (1923).] A. W.

211. Collision of Electrons. H. S. W. Massey and C. B. O. Mohr. *Roy. Soc., Proc.* 132. *pp.* 605–630, *Aug.* 1, 1931.—The scattering of electrons by atoms is considered when the possibility of interchange between incident and atomic electron is taken into account. The theory of Oppenheimer is used to calculate the scattering of electrons in helium and hydrogen, the angular distribution for elastic and inelastic scattering and the total cross-sections corresponding to elastic and to the most probable inelastic collisions, being given. The probabilities of excitation of the triplet states of helium are calculated and the results agree well with the experimental. The difference between the optical excitation functions of the triplet and singlet lines is clearly shown. It is found also that the effect of exchange on the scattering by heavy atoms should be important to fairly high voltages, *e.g.*, 500 volts in neon. The paper is largely mathematical. G. C. McV.

212. New Phenomenon Due to the Passage of a Beam of Electrons through Diaphragms. W. Seitz and G. Harig. *Phys. Zeits.* 32. *pp.* 635–639, *Aug.* 15, 1931.—When an approximately parallel beam of electrons is passed through a set of diaphragms and then allowed to strike a photographic plate, a black spot is obtained in the centre of the plate, whose shape is determined by the experimental conditions [see Abstract 1428 (1930)]. The influence of the experimental conditions on the shape has been further studied. F. J. W.

213. Diffraction Experiments with Very Fast Electrons. E. Rupp. *Ann. d. Physik,* 10. 8. *pp.* 927–946, *Aug.* 24, 1931.—The atomic form factor for gold is determined from the intensity of the diffraction rings obtained with electrons of 220 kV velocity. It increases for decreasing angles of scattering more rapidly than for electrons of 20–60 kV velocity. In the case of gold foil, and when fairly monochromatic beams of electrons are used, new rings appear within the ring (III) if the exposure is sufficiently prolonged. The position of these rings can be uniquely described by means of fractional order numbers $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}$. The rings with $n = \frac{1}{2}$ were also found in the case of Ag and Pb foil, but not in the case of Al. This appears to indicate that the appearance of the rings is connected with the greater reflective power of the heavier atoms. To test de Broglie's relation, more accurate measurements with very fast electrons (100–250 kV) were made. A table of de Broglie wave-lengths with the corresponding electronic velocities is appended. H. L. B.

214. Photoelectric Properties of Cadmium, Especially as Affected by Gases. H. Bomke. *Ann. d. Physik*, 10. 5. *pp.* 579–615, *July* 29, 1931.—By depositing vaporised cadmium in carefully degassed cells it is possible to obtain cadmium layers whose long-wave limit lies at 304 mμ and which give a photoelectric effect that can be readily reproduced and remains reasonably constant in time. The long-wave limit is not displaced to lower values by heating the cell again. The introduction of gas strongly affects the photoelectric action of the cell; it becomes reduced by the gases oxygen, nitrogen, hydrogen, carbon-dioxide and argon. Water vapour increases the photoelectric output and displaces the limit of the effect towards considerably longer wave-lengths. Cadmium layers, deposited in cells that had not been previously baked out, had a long-wave limit at about 325 mμ, which is presumably due to the presence of traces of water vapour. Moist inert gases in the cell introduced a lag effect, which showed itself in reduced sensitivity after a little use; at the same time the long-wave limit receded. H. L. B.

215. Selective Photoelectric Effect. R. Suhrmann. *Zeits. f. wiss. Phot.* 30. *pp.* 161–171, *Aug.*, 1931.—Discusses the action of a layer of H atoms in producing a selective photoelectric effect in a layer of K. Any substance which is capable of combining with K produces a similar effect, particularly O, S, Se and Te. It still remains doubtful whether the spectroscopic maximum is a matter of resonance or of light absorption. Resonance would be indicated by the quantic equivalent law only applying at the maximum of selectivity. E. E. F. d'A.

216. Amplification of Photoelectric Currents. R. P. Lejay. *Onde Élec.* 10. *pp.* 363–368, *Aug.*, 1931.—Describes a circuit containing a Phillips electrometer valve and two amplifying valves for amplifying photoelectric currents of the order of 10^{-12} ampere. The transits of Jupiter, Procyon, and β Leonis were registered with this apparatus and an objective of 20 cm. dia. The records are similar in appearance to those obtained with selenium in 1913. E. E. F. d'A.

217. Photo-Conductivity and Photovoltaic Effects. R. Audubert and J. Roulleau. *Comptes Rendus*, 193. *pp.* 291–292, *Aug.* 3, 1931.—Some substances exhibiting photovoltaic effects show in the solid state a diminution of resistance under the action of light. According to some hypotheses the primary electronic displacement provokes an activation of the molecules of the photo-sensitive body and thus a displacement of chemical equilibria. From this theory it would follow that the most active radiations are the same in the two phenomena, and this is often not the case. As it is not permissible in testing this hypothesis to use the values of photo-conductivity in the solid state, the authors have measured directly the changes of resistance of different photo-sensitive electrodes (CuO, Cu_2O, CuO/Cu_2O, CuI, Ag_2S), associating them with a reversible electrode (Hg/Hg_2Cl_2 or Ag/AgI), the liquid being KCl or KI. The resistances of the couples were found to depend on the method of measurement. With Mance's method the values obtained were much higher than with an apparatus like Kohlrausch's bridge. This shows, incidentally, that the most important part of the resistance of an electrode is in the transition layer due to polarisation. On studying various substances by the two methods referred to, it was found that substances showing but feeble photo-variation of resistance were amongst those which showed the highest photovoltaic effects. Moreover, in the same body there was frequently found to be no relation between the photo-potentials and the variations of resistance. As regards the influence of the intensity of light on the photo-conductivity and on the photovoltaic effect, it was found to be very different in the two cases. The photo-potentials were found to be proportional to the square root of the variable, whilst the change of resistance was proportional to the intensity. In short, photo-conductance is not the essential factor in photovoltaic effects: for some photo-sensitive substances it is a secondary phenomenon. J. J. S.

218. Variations in Sensitiveness of Cuprous Oxide Cells. P. Auger and C. Lapicque. *Comptes Rendus*, 193. *pp.* 319–321, *Aug.* 10, 1931.—Cuprous oxide cells, consisting of copper with a thin layer of cuprous oxide and covered with a gold or silver film by kathode sputtering, show an e.m.f. under illumination amounting to several hundred microamperes per watt of incident light. The authors determined this photoelectric efficiency by means of an arc, a Hilger monochromator, and a thermopile. The maximum is at 4750 Å. for silver films and at 5000 Å. for gold films. They also determined the absorption of the silver and gold films. When this is done, the curves become exactly congruent, thus showing that the film takes no part in the photoelectric effect, but only serves to drain away the electrons. E. E. F. d'A.

219. Ionisation in Gas-Filled Photoelectric Cells: (i) The Inert Gases in Cæsium-on-Silver Photoelectric Cells, and (ii) Time Lag in Gasfilled Photoelectric Cells. W. F. Tedham. *Phil. Mag.* 12. *pp.* 224–232, *Aug.*, 1931. *Supplement.*—The relative advantages of He, Ne, A, Kr and Xe as fillings in photoelectric cells sensitive to visible or infra-red radiation are investigated. The results indicate that all the gases depress the vacuum sensitivity when the anode potential is 20 volts or less. At 30 volts, He and Ne depress the sensitivity while A scarcely affects it. Kr first increases the sensitivity with a maximum at 80 microns of mercury pressure and then depresses it at higher pressures. Xe at 30 volts showed amplification. All gases showed amplification at higher voltages, many of the curves exhibiting a maximum effect. An amplification of 5 is usually practical at illuminations as high as 0·16 lumen and with a kathode sensitivity of about 6 μA per lumen. By using low pressure and high voltages, greater amplification is obtained for gas of higher atomic number. Possible causes of the phenomena of time lag in photoelectric cells are very briefly discussed. J. S. G. T.

220. Action of Hydrogen on a Potassium Surface. S. Rijanoff. *Zeits. f. Physik*, 71. 5–6. *pp.* 325–338, *Aug.* 29, 1931.—Photoelectric pro-

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19

perties were studied in a potassium surface subjected at certain intervals to the influence of hydrogen atoms. The effect is an immediate increase—up to 20 or 40-fold—of the photoelectric sensitiveness of pure potassium, followed by a reduction to below the original amount, which reduction is independent of the duration of action of the hydrogen. But the amount of hydrogen absorbed for the maximum photoelectric current is about half the amount absorbed for minimum current. E. E. F. d'A.

221. Steel Oscillator of Pure Phase with Reaction Coupling. C. H. Becker. *Ann. d. Physik*, 10. 5. *pp.* 533–557, *July* 29, 1931.—A standard of frequencies of the order 5000 sec.$^{-1}$ is described and investigated. It consists of a self-excited composite steel rod executing longitudinal vibrations in a specially devised valve circuit. Tests showed that with this arrangement the temperature coefficient of the frequency was less than 10^{-6} per degree and that within certain easily attainable conditions the frequency was independent of the working conditions to within $\pm 10^{-6}$ of its value. H. L. B.

222. Falling Characteristic of Oscillating Crystals. F. Seidl. *Zeits. f. Physik*, 71. 3–4. *pp.* 227–237, *Aug.* 15, 1931.—The various theories hitherto advanced to explain the origin of the falling characteristic of oscillating crystals are discussed. The formula given by Sixtus for the thermal explanation of the effect is extended, it being shown that the fall of temperature is an important factor which must be taken into account. A. W.

223. Change of Magnetic Moment of the Nitric Oxide Molecule with Temperature. R. Stössel. *Ann. d. Physik*, 10. 4. *pp.* 393–436, *July* 21, 1931.—Relative values of the susceptibility of NO were measured at different pressures for absolute temperatures from 135°·5 to 289°·2. The method used involved a small balance and a compensated field, with oxygen gas as a standard. At constant temperature the susceptibility of NO gas is proportional to the pressure, and with change of temperature the magnetic moment, in Bohr magnetons, varies in agreement with van Vleck's theory [see Abstract 1986 (1928)]. G. E. A.

224. Measurement of Magnetic Susceptibilities. P. Kapitza and W. L. Webster. *Roy. Soc., Proc.* 132. *pp.* 442–459, *Aug.* 1, 1931.—The method proposed has the advantage that the body examined can be fixed in a definite position, whilst the balance system used to measure the magnetisation is entirely separate from the body which in consequence can be subjected to any change of physical conditions without interference with the measurements. The theory and construction of the balance is described in detail, and it is shown that the method can be employed with advantage for most experiments carried out by other methods. H. H. Ho.

225. Anomalous Diamagnetism of Bismuth. R. N. Mathur and M. R. Varma. *Indian Journ. Phys.* 6. *pp.* 181–192, *Aug.*, 1931.—After discussion of previous work and experimental detail the paper records the results of the authors, showing that they find both bismuth sol and its fine powder are much less diamagnetic than the metal crystals. The present work indicates that the anomalous diamagnetism of Bi is not wholly bound up with its crystal structure, but, on the other hand, the cases where the powder regains almost its original value merely by washing in tartaric acid indicates that a great deal of the observed fall in the diamagnetism of powdered Bi is due to oxide impurity. X-ray evidence of the loss of crystal structure of Bi on powdering is absent. Experimental evidence is quoted to show that during pulverisation the surface of the Bi particles becomes coated with oxide. The work is confirmed by similar treatment of Sb, where the original value for the diamagnetism is practically regained by washing the powder with suitable acids. S. G. B.

226. Influence of Temperature on the Diamagnetism of Liquids. R. N. Mathur. *Indian Journ. Phys.* 6. *pp.* 207–224, *Aug.*, 1931.—Magnetic susceptibilities of a few aliphatic and aromatic liquids and water have been investigated at different temperatures (from room-temperature to 80° C.). In the case of water, it is found that its specific diamagnetic susceptibility increases with rise of temperature. In the case of aliphatics, practically no change is observed, but the diamagnetism of aromatics, and particularly nitro-benzene, shows a definite decrease with rise of temperature. It is well known that the aromatics exhibit a stronger magnetic birefringence than the aliphatics. Also the magnetic birefringence of a liquid decreases at higher temperatures, because the effect of heat is to disturb the molecular orientation produced by the magnetic field. It is therefore suggested that the decrease in the diamagnetism of aromatics might also be due to their different degrees of molecular orientation at different temperatures. AUTHOR.

227. Diamagnetism and the Colloidal State. S. R. Rao. *Indian Journ. Phys.* 6. *pp.* 241–259, *Aug.*, 1931.—It has been shown by Vaidyanathan that the diamagnetic susceptibilities of graphite, antimony and bismuth decrease with the size of the particles. The author finds that the values of χ for colloidal particles of Bi and Sb decrease as the size of the particle decreases, at first slowly and then rapidly, till at diameters less than $0 \cdot 5\mu$ χ tends to a constant value. For diameters of 10μ the susceptibility is less than for the solid metal. With purified bismuth and graphite, a graph drawn between χ and $1/d$, where d is the diameter of the particles, gives a straight line. Attention is drawn to Honda's experiments, and the possibility of explaining the results on a basis of Richardson's theory is discussed. G. E. A.

228. Magnetic Alloys and Their Properties. H. H. Potter. *Phil. Mag.* 12. *pp.* 255–264, *Aug.*, 1931. *Supplement.*—The tendency of the element Mn to form binary and ternary alloys with other nonferromagnetic elements, which show pronounced ferromagnetism, is discussed, especially with reference to the ternary system Ag-Mn-Al. This alloy possesses ferromagnetic properties with a maximum saturation intensity of about 70 units per c.c. at or near a point represented by Ag, five; Mn, one; and Al one atoms, respectively. The Heusler alloy system (Cu-Mn-Al) is more magnetic, having an optimum saturation intensity of over 400 units per c.c. The new alloys have a Curie point of about 360° C. and great coercive force, in most magnetic specimens about 5000 gauss, or even greater. Two magnetic compounds in the binary system of Mn-Sn are also examined. $SnMn_4$ has a saturation intensity of 100 units and Curie point 150° C. approx. The compound $SnMn_2$, obtained after suitable annealing, had as high an intensity as 470 units/c.c. and Curie point at 0° C. This latter substance presents an interesting exception to the general rule that high saturation intensities have usually the accompaniment of high Curie points. Its strong ferromagnetism has previously been missed on account of its low Curie point, and it appears as unique in that, at the same time as it has a low Curie point, it possesses a saturation intensity almost equal to that of nickel. S. G. B.

229. Influence of Hydrostatic Pressure on the Critical Temperature of Magnetisation for Iron and Other Materials. L. H. Adams and J. W. Green. *Phil. Mag.* 12. *pp.* 361–380, *Aug.*, 1931. *Supplement. Terr. Mag.* 36. *pp.* 161–169, *Sept.*, 1931.—Measurements were made on the effect of pressure on the magnetic inversion temperature for iron, nickel, magnetite, nickel steel (35 % nickel) and meteoric iron from the Canyon Diablo meteorite. The materials, in the form of small transformers, were subjected to pressure in a water-jacketed bomb with internal electric heating; the primary coil was supplied with 60-cycle current, the output of the secondary being stepped up with an amplifier, rectified and then read on a microammeter. When the specimen was heated, the deflection dropped to zero at the inversion temperature. Pressures as high as 3600 bars were used. The results obtained show that the effect of pressure on the inversion temperature is practically nil, but the possibility of a slight decrease in temperature with increasing pressure is not excluded. From this it follows, since the energy change is of considerable magnitude, that the volume change accompanying the magnetic transformation is zero, or very small. If, as seems reasonable, this tendency still holds qualitatively at the very high pressure in the interior of the earth, it must be concluded that the nickel-iron core, which has a diameter of about one-half and a volume about one-ninth of the earth's, is at a temperature far above that at which it could be magnetic. The nickel-iron core, therefore, in spite of its great volume, has no important direct influence on the earth's magnetic field. A. W.

230. Magnetisation and Magneto-Caloric Effect. F. Bitter. *Phys. Rev.* 38. *pp.* 528–548, *Aug.* 1, 1931.—The magneto-caloric effect is defined as the reversible evolution of heat accompanying a change in the magnetisation of a ferromagnetic substance, in contradistinction to the irreversible evolutions known as hysteresis. Assumptions are made and discussed regarding the mechanism of magnetisation. The essential result of this discussion is that a sudden change in the applied field gives an unstable distribution of energy, which to reach equilibrium brings about a reversible change in temperature. A detailed comparison is undertaken between experimental observations of the magneto-caloric effect in nickel for high fields and with temperatures not too near the Curie point. Agreement is satisfactory. Akulov's static theory for single crystals is considered, and it is pointed out that experiments on the magneto-caloric effect of single crystals would be very helpful in determining the mechanism of magnetisation. H. M. B.

231. Anisotropy in Magnetic Materials. O. Dahl and J. Pfaffenberger. *Zeits. f. Physik,* 71. 1–2. *pp.* 93–105, *Aug.* 4, 1931.—It is shown that the magnetic anisotropy of magnetic metals crystallising in the regular system, such as iron, nickel and alloys of these metals, makes it possible to investigate their textures, as modified by working and by heat treatment. The fibre planes and directions can be found by means of a small disc of sheet metal, mounted so that it can rotate in a magnetic field; the position in the field is found to depend on the direction in which the sheet was rolled. Differences are pointed out between the behaviour of iron and nickel. Instead of suspending the sheet metal it may be fixed, and the behaviour of a magnet suspended above it may be observed. The effect of stress in the metal can also be investigated. The results so far obtained are of a qualitative nature, but further investigations are being made, and it is hoped that quantitative measurements will be possible. H. N. A.

232. Transverse Magnetostriction Effect. G. Dietsch and W. Fricke. *Phys. Zeits.* 32. *p.* 640, *Aug.* 15, 1931.—Two methods of measuring the transverse effect are described. In the first method the bar is placed centrally in a brass cylinder, with which it forms a condenser within the magnetising coil. The displacement produced by the transverse effect causes a measurable change of capacity. In the second method the test bar is placed axially within a horizontal magnetising coil and is connected by a system of levers to a plate condenser in which the transverse magnetostriction causes capacity change. The second method was applied in the case of a rod of pure electrolytic iron, and at the same time the length change was also measured. The graphs of the two effects on a common axis of field strengths show a positive change in length when there is a negative change in radius and vice versa. The maxima for the two effects do not occur, however, at the same field strength. G. E. A.

233. Motion of a Charged Particle. Part I. C. Störmer. *Zeits. f. Astrophysik,* 3. 1. *pp.* 31–52, *June* 29, 1931.—The motion of a charged particle under the combined action of the force due to a magnetic dipole, and of a central force varying inversely as the square of the distance from the dipole. Two first integrals of the motion can be found and also a complete approximate solution of the problem in terms of elliptic functions. G. C. McV.

234. Motion of a Dirac Electron in a Magnetic Field. L. D. Huff. *Phys. Rev.* 38. *pp.* 501–512, *Aug.* 1, 1931.—Solutions of the Dirac wave equation representing a free electron moving in a uniform magnetic field are obtained. The functions are similar to those obtained by Landau and by Uhlenbeck and Young as solutions of the Schrödinger equation. A wave packet is constructed representing a beam of electrons passing through a slit. The results agree with the classical predictions to terms of the order of the de Broglie wave-length of the electron divided by the radius of curvature of its classical path. For experimental cases this ratio is of the order 10^{-8} to 10^{-10}. Hence it is concluded that the difference between magnetic deflection measurements of e/m and other determinations cannot be explained as a quantum effect. AUTHOR.

235. Electron-Inertia Effect and the Determination of m/e for the Free Electrons in Copper. S. J. Barnett. *Phil. Mag.* 12. *pp.* 349–360, *Aug.*, 1931.—If the current in a circular or cylindrical coil of wire free to move about its axis is altered, the free electricity will be accelerated and the coil itself will be accelerated in the opposite direction, the changes of angular momentum being equal in magnitude and opposite in sign. This is a special case of three inertia effects described by Maxwell and predicted to exist in conductors if the electric current is due to the motion of one kind of electricity only and if this electricity has inertia. This effect has been observed by the author for the first time and its investigation is described in this paper. A null-graphical method and a deflection method were employed, the former giving the more reliable results. The coil used had the form of a long solenoid wound on a cylinder of brass or glass, the whole being designated the rotor. The torque on the rotor produced by changing the current had its effect in producing rotation annulled by another torque. If $\mu =$ the magnetic moment of the rotor, and $j' =$ the angular momentum of the free electricity, ρ the ratio $j'/\mu = 2m/e$. From the experiments made on different dates, the following values of ρ in e.m.u. were obtained: $1 \cdot 15 \times 10^{7}$, $1 \cdot 06 \times 10^{-7}$, $1 \cdot 09 \times 10^{-7}$, the mean being $1 \cdot 10 \pm 0 \cdot 03$. The first of the three is regarded as probably most reliable from the absence of disturbances during the observations. This result is also the closest to the standard value of $2m/e$, *viz.*, $1 \cdot 13 \times 10^{-7}$ e.m.u. Both methods used give for the ratio of the mass of the electron to its charge in the copper conductor values which are, within the probable experimental errors, equal to the ratio determined for free electrons. J. J. S.

236. Fundamental Theorems of Electrodynamics and of the Statics of Elastic Solids. D. Bonvicini. *Accad. Lincei, Atti,* 13. *p.* 594, *April* 26, 1931.—Under the same title [see Abstract 4115 (1930)] the author published some notes on the analogy between some problems of elastic solids and certain theorems in electrodynamics. He now continues the study of these analogies in this note by comparing the double theorem of Castigliano, the theorem of reciprocity of Volterra as extended by Somigliana, and Colonnetti's principle of reciprocity similarly extended, with certain electrodynamic theorems. J. J. S.

237. Electromagnetic Fields Derived from Non-Commuting Potentials. B. Cassen. *Nat. Acad. Sci., Proc.* 17. *pp.* 430–434, *July,* 1931.—A mathematical paper in which the components of the electric field, the magnetic field, and the current vector are defined and derived from an arbitrary *q*-number four potential. These quantities are shown to satisfy a set of equations similar to Maxwell's, which reduce to the latter for a set of mutually commuting potentials. The form of the equations with non-commuting potentials suggests a modification of the commutation laws for the electromagnetic field quantities given by Heisenberg and Pauli. N. D.

238. Index Operators. W. E. Sumpner. *Phil. Mag.* 12. *pp.* 201–224, *Aug.,* 1931. *Supplement.*—The author explains the respective natures of Heaviside's operator, p, and Boole's symbols, including δ, D, E and Σ_1, and discusses (1) the Heaviside function $H(t)$ in conjunction with Fourier series and integrals, and (2) the operator axiom, *viz.*, that in $F(t) = \phi(p)f(t)$, $\phi(p)$ can be converted to a more convenient working form, $\phi'(p)$, by any mode of analysis treating p as an algebraic quantity. The justification of this axiom is shown to demand that (1) the operator p must have all the characteristics of an algebraic quantity, and (2) the manipulation of $f(p)$ must be carried out with strict attention to the requirement of identity. The first requirement rejects Boole's differentiator, δ, in favour of Heaviside's index operator and makes intelligible the use of fractional powers of p. Illustrative examples are given. J. S. G. T.

239. Theory of Induction. M. Biot. *Ann. Soc. Sci. de Bruxelles,* 51. *pp.* 94–127, *Aug.* 8, 1931.—Advances certain general considerations on the solutions of Maxwell's equations in the case of sinusoidal fields when the displacement current is negligible. E. E. F. d'A.

APPARATUS AND INSTRUMENTS.

240. Julius Suspensions. M. J. Brevoort. *Rev. Sci. Instruments*, 2. *pp*. 447–449, *Aug*., 1931.—A modified form of galvanometer suspension is described which damps out vibrations when in a building subject to unusually severe vibrations. The suspended frame is made more rigid and an improved means of adjusting the supporting wires to the same degree is used. This gives increased restraint to motion in any direction other than that parallel to a line from the point of support to the centre of gravity of the suspension. It possesses advantages in stability, simplicity and ease of adjustment. R. S. R.

241. Theory and Use of the Valve Potentiometer in the Measurement of E.M.F. F. Müller. *Zeits. f. phys. Chem*. 155. *Abt. A*. 5–6. *pp*. 451–465, *Aug*., 1931.—The theoretical foundations, and the constructive principles of thermionic valve apparatus for measuring the e.m.f. of galvanic cells of small electrode capacity or abnormally high internal resistance, are considered. The factors to be observed in the grid circuit are discussed and the points of the anode current characteristic suitable for accurate working are given. The results obtained are applied in the construction of an apparatus which avoids polarisation in the cell under test. Sensitiveness and accuracy, and their limits, are discussed. [See also Abstract 1391 (1931).] T. H. P.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

242. Limitations of the Single-Valve Unit. W. E. Schall. *Brit. J. Radiology*, 4. *pp*. 391–393; *Disc*., 394, *Aug*., 1931.—It has been shown that if the current passed through an X-ray tube in a single-valve (*i.e.*, half-wave rectified) outfit be increased, the X-ray output at first rises, but later falls for high currents. It is suggested that this effect may be due to a spreading of the electron stream consequent on the mutual repulsion, which would increase the size of the focal spot. In the discussion other causes for the falling-off of X-ray intensity were suggested, notably the possibility of its being due to the regulation of the transformer. G. E. B.

243. Gaiffe Milliampere-Second Relay. A. C. Gunstone and E. J. W. Watkinson. *Brit. J. of Radiology*, 4. *pp*. 395–399; *Disc*., 399–401, *Aug*., 1931.—A description of a relay designed to cut off current after the passage of a certain quantity of electricity. The instrument, which is designed specially for X-ray work, operates on the l.t. side of the main h.t. transformer. In design the relay is essentially similar to a watt-hour meter of the induction type. The discussion concerns mainly the consistency of the relay. G. E. B.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

244. Adsorption of Hydrogen Cyanide and of Carbon Dioxide at Low Pressures by Activated Charcoals. A. J. Allmand and R. Chaplin. *Roy. Soc., Proc.* 132. *pp.* 460–479, *Aug.* 1, 1931.—Using an adaptation of technique previously described [see Abstract 997 (1929)], the adsorption isothermals of HCN have been determined on four different specimens of evacuated activated charcoals, at 25° and over a pressure range of about 10^{-3} to 0·2 mm. The results indicate a resemblance between water and HCN considered as sorbates. Similar data have been obtained for the adsorption of CO_2 on nine different charcoals, at 25° and over an average pressure range of 10^{-2} to 0·15 mm. The results indicate the existence of two very distinct types of adsorption process, of which both are active with steam or air-activated charcoals, but one only with chemically activated charcoals. The difference in charcoal type mentioned is ascribed to the fact that, in chemically activated charcoals the regions of highest potential are occupied by mineral matter adsorbed during the activation. The work of other authors is discussed in the light of the present results. H. H. Ho.

245. Adsorption of Nitrogen by Condensed Atomic Platinum. S. H. Bastow. *Chem. Soc., J. pp.* 1950–1959, *Aug.*, 1931.—It has been observed that when metallic wires are vaporised by heating to high temperatures a steady diminution of pressure of any residual gas may occur. The present investigation follows the work of Jones and Rideal on the combustion of platinum wherein it was noted that a slow " clean up " occurs. It is now shown that when platinum is condensed in a thin film on a very cold glass surface nitrogen is strongly adsorbed. A roughly quantitative relationship is established. The adsorbed nitrogen reacts with hydrogen to form ammonia. J. K.

246. Gaseous Adsorption. Part I. Influence of Hydrogen Sulphide on the Rate of Adsorption of Hydrogen by Platinum. E. B. Maxted. *Chem. Soc., J. pp.* 2203–2207, *Aug.*, 1931.—The fact that the bulk of hydrogen is adsorbed relatively quickly while further adsorption occurs at a slower rate is examined from the point of view of Taylor's conception who postulated two modes of adsorption, each associated with its own critical energy, corresponding with the adsorption of hydrogen in the molecular and atomic states respectively. In the present work, the effect of a catalyst poison on the rate of adsorption is examined. The results show that the poison effects a general retardation on the whole process of adsorption, increasing with the poison content. J. K.

247. Adsorption of Polar and Non-Polar Substances by Mercury. H. Cassel and F. Salditt. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 321–342, *Aug.*, 1931.—The maximum drop pressure method is developed into a process for measuring with an accuracy (0·1 %) hitherto unobtainable the surface tension of mercury and the lowering of its surface tension by foreign gases, air being excluded. The adsorption measurements of superheated vapours are given at 50° to about 60 % of their saturated pressure for the following substances having dipole moments from 0 to 3·8 e.s.u.: C_6H_6, C_6H_{12}, *n*-C_6H_{14}, C_3H_5OH, *n*-C_3H_7OH, *n*-C_4H_9OH, C_2H_5OH, CH_3OH, H_2O, *iso*-$C_5H_{11}OH$, CH_3NO_2. Water with a dipole moment of 1·8 up to a pressure of 62 mm. has no action on the surface tension, whereas the non-polar substances, benzene, cyclohexane and hexane, are strongly adsorbed at this pressure range. J. K.

248. Adsorption and Surface Energy at the Boundaries of Different Phases. B. Iliin. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 403–416, *Aug.*, 1931.—The theory of the reversal of the adsorption series in solutions is discussed and criticised. The assumption of the competition of the electric moments of the adsorbing molecules permits of an explanation being made of several other phenomena, such as adsorption and desorption of dissolved bodies at the boundaries of different phases. In addition, it explains the phenomena of inversion of the adsorption series, and the heat of wetting for true hydrophobe and hydrophile surfaces by polar and non-polar solvents. F. J. B.

249. Influence of Adsorbed Gas Layers on the Optical Constants of Mercury. Elsbeth Herschkowitsch. *Ann. d. Physik,* 10. 8. *pp.* 993–1016, *Aug.* 24, 1931.—The influence of adsorbed hydrogen, oxygen, carbon dioxide, air, acetylene, neon and nitrogen on the optical constants of mercury has been studied. Neon and nitrogen have no measurable effect. The thickness of the adsorbed layers as calculated from the Drude equation is from 5 to 15 molecular diameters. F. J. W.

250. Heat of Adsorption of Atomic Silver and Halogen on Silver Chloride, Bromide and Iodide from Photochemical, Thermochemical and Electrochemical Data. H. H. Schmidt. *Zeits. f. wiss. Phot.* 30. *pp.* 147–156, *Aug.*, 1931.—The results obtained are:—

Halide.	Heat of Adsorption of Atomic Silver.	Heat of Adsorption of Atomic Halogen.
	K. cal.	K. cal.
AgCl	33	16
AgBr	22	22
AgI	11·5	22·5

The adsorbed iodine atoms which result from the photochemical decomposition of silver iodide are unable to combine to form molecules. Such combination does take place in the case of the chloride and bromide. The theory of the latent image is discussed in its relation to these results. F. J. W.

251. X-Ray Analysis of Mercerised and Native Cellulose. W. Schramek. *Zeits. f. phys. Chem.* 13. *Abt. B.* 6. *pp.* 462–474, *Aug.*, 1931.—The quantitative relations between the intensity of the equatorial interference of fibre preparations containing both native and mercerised cellulose in known proportions. The methods used technically to mercerise cellulose give a product which contains unchanged cellulose. It is possible to use X-ray diffraction patterns to determine quantitatively the relative proportions of mercerised and native cellulose in such a product. F. J. W.

252. Growth of Metal Crystals in Metal Vapour. M. Straumanis. *Zeits. f. phys. Chem.* 13. *Abt. B.* 4–5. *pp.* 316–337, *Aug.*, 1931.—The growth of crystals of zinc and cadmium from vapour is studied. A carefully cleaned glass tube containing the metal was evacuated. The metal was fused and any adsorbed gas removed by the pump, and the tube was sealed. The tube was heated in an electric tube furnace to the melting-point of the metal, and condensation of the metal took place at the cooler portions of the tube. It was found that when nuclei were formed they grew to large crystals when their temperature was close to the melting-point of the metal. Below a definite temperature the growth was greatly retarded and small crystals resulted. For zinc the temperature was below 375° C. The results were generally in harmony with the theory of homopolar crystal growth. F. J. B.

253. X-Ray Investigation of Tin-Antimony Alloys. E. G. Bowen and W. M. Jones. *Phil. Mag.* 12. *pp.* 441–462, *Aug.*, 1931.—Pure tin has a simple tetragonal structure, unit cell a 5·818, c 0·546 Å. Sb forms a solid solution therein up to 9 %, a changing gradually to 5·836. With further increase of Sb the compound SbSn, with NaCl structure, appears, in which both Sn and Sb form solid solutions to maxima of (probably) 10 % and 4 % respectively, a decreasing from 6·126, through 6·120 for pure SbSn, to 6·110 for the solid solution saturated with Sb. With further increase of Sb its face-centred rhombohedral structure appears with a 6·220 and α rising from 86° 30′ to 87° 24′ for pure Sb. These results agree substantially with those of Broniewski and Sliwowski, save that the compound is SbSn and not Sb_2Sn_3 [see Abstract 2855 (1928)]. C. A. S.

254. Miscibility Gaps in the Systems Pb-Cu and Pb-Cu-Zn. S. Briesemeister. *Zeits. f. Metallkunde*, 23. *pp.* 225–230, *Aug.*, 1931.—Pb and Cu are soluble in all proportions at temperatures above 1000° C. The solubility isotherms for the Pb-Cu-Zn system have been determined at temperatures of 835°, 955°, 1005°, 1060°, and 1110° C. The critical solution temperature is between 1130–1140° at a composition 35 % Cu, 50 % Pb and 15 % Zn. F. J. W.

255. Constitution of Al-Fe-Si Alloys Rich in Aluminium. V. Fuss. *Zeits. f. Metallkunde*, 23. *pp.* 231–236, *Aug.*, 1931.—The iron silicides, α-FeSi and β-FeSi, reported by Dix and Heath from an examination of the Al-Fe-Si system, are shown to be a compound of the approximate composition $Al_6Fe_2Si_3$. It has only a slight solubility in Al. F. J. W.

256. Influence of Cold Drawing on the Plasticity [of Metals] at High Temperatures. E. Schmid and G. Wassermann. *Zeits. f. Metallkunde*, 23. *pp.* 242–243, *Aug.*, 1931.—In experiments carried out between 250° and 400° it is shown that hard copper wires flow much more easily than soft copper wires under the same conditions of tension. F. J. W.

257. Effect of Temperature on the Corrosion of Zinc. G. L. Cox. *Indust. and Engin. Chem.* 23. *pp.* 902–904, *Aug.* 1, 1931.—It is shown that the corrosion of zinc in distilled water continuously saturated with air is affected largely by temperature. The most important factor influencing these rates at the different temperatures is the physical nature of the corrosion-products film. The experimental results, which show a maximum rate of corrosion at 63° C., above which the rate decreases rapidly, are satisfactorily explained by a consideration of the physical properties of the corrosion products film, rate of transfer of dissolved oxygen, and oxygen concentration of the corroding media. C. O. B.

258. Photochemical Processes. *Faraday Soc., Trans.* 27. *pp.* 359–572, *Aug.*, 1931.—A general survey of the subject comprising 27 papers, together with general discussions on them by various contributors, arranged under four main headings as follows:—

PART I. MOLECULAR SPECTRA IN RELATION TO PHOTOCHEMICAL CHANGE.

" Introductory Paper," by **R. Mecke.** A review of the situation of band spectroscopy with reference to photochemical reactions. Three possibilities exist for a photochemical reaction: (1) With excited molecules; these show no peculiarities in the absorption spectrum in the appropriate region, gases, for instance, showing spectra with the usual line structure and fluorescing power. The primary reaction must be bimolecular, the quantum field being usually small and dependent on pressure. The small quantum yield from short-lived (10^{-8} sec.) excited molecules or atoms may be improved by exciting metastable (long-lived) molecules or atoms, or by making use of resonance effects. (2) With primary dissociated molecules; recognised by the continuous spectrum (with gases), often preceded by an ordinary band spectrum with a convergence limit, and by loss of fluorescence. (3) With predissociated molecules; these showing suddenly, within a relatively small spectral region, diffuseness in the band spectrum, and loss of the fluorescent power. The molecules have a greatly increased tendency to dissociation (mean life $\sim 10^{-11}$ sec.), and thus act exactly as primarily dissociated molecules.

" Photochemical Ozone Equilibrium in the Atmosphere," by **R. Mecke.** Excluding electric discharges in the upper atmosphere, of which practically nothing is known, the ozone layer at high altitudes must be due to a photochemical reaction. On this assumption it is shown that the photochemical decomposition of ozone by ultra-violet light below λ2655 is a primary reaction, whilst the formation of ozone requires excited oxygen molecules. Thus the two primary photochemical reactions leading to an equilibrium of O_3 are: $O_3 + h\nu(<\lambda 2655) = O_2^{\prime} + O^{\prime}$ and $O_2 + O_2^{\prime\prime} (< \lambda 2025) = O_3 + O^{\prime}$, excited atoms being the end products in each case. At very low pressure and low ozone concentration, the law of equilibrium concentration $[O_3]^2/[O_2]^3 = K$ is obeyed. An expression connecting the maximum O_3 concentration with the atmospheric pressure at which this exists is deduced, and application to this of experimental data gives the value $\sim 2 \cdot 1^{-4}$ c.c. per c.c. of air for the maximum concentration.

" Ultra-Violet Absorption Spectra of Acetylene and Formaldehyde," by **G. Herzberg.** Investigation of these spectra with a 2 m. vacuum spectrograph shows that both molecules exhibit two regions of discontinuous absorption corresponding with two stable excited electronic levels of the molecules. The longer wave-length system of formaldehyde has already been observed by Henri and Schou [see Abstract 3225 (1928)], whose vibrational analysis is now corrected. The vibrations and photochemical processes in the different states of these molecules are discussed.

" Absorption Spectra and the Optical Dissociation of Hydrides of the

Oxygen Group," by **C. F. Goodeve** and **N. O. Stein.** The absorption spectra of the four hydrides of the oxygen group exhibit thresholds or regions of rapidly increasing extinction coefficients. These regions shift progressively towards lower frequencies on passing down the series from water, and the corresponding energy just suffices to dissociate the molecules into hydrogen molecules and ^1D non-metallic atoms. Otherwise H_2S and H_2Se are the only two that show great similarity. Second thresholds shown by H_2O and H_2Te and attributed to the production of the ^1S non-metal atoms do not occur with the other two gases. The thermochemical heat of dissociation of H_2Te is evaluated on the assumption that the threshold of absorption of this substance corresponds with the same primary photochemical action as with the other hydrides; the conditions involved in this assumption are discussed. In the *Discussion* on this paper, **G. Herzberg** regards it as unlikely that, by light absorption in one process, the normal H_2 molecule is split off from these hydrides, as the H atoms are not bound together in them. He considers the agreement of the threshold frequency with the energy necessary for such process to be fortuitous. Replacement of the incorrect values used for the heat of dissociation of O_2 and the energy of the metastable ^1D level of O by the correct values invalidates the authors' photochemical interpretation of the continuous absorption spectrum. This first continuous absorption spectrum of H_2O more probably corresponds with the dissociation $H_2O \rightarrow H + OH$ (normal). The formation of S from H_2S in consequence of light absorption is then explainable thus: $HS + HS = H_2S + S$.

"Photochemical Properties of the Carbonyl Group," by **F. W. Kirkbride** and **R. G. W. Norrish.** Various examples of the photochemical decomposition of aldehydes and ketones are reviewed, and an account is given of new work on the decomposition of methylglyoxal and formaldehyde. Decomposition giving CO always ensues when absorption occurs in the "CO band" common to aldehydes and ketones which lies between 3500 and 2500 Å. As was suggested by de Hemptinne for benzaldehyde, this decomposition is associated with a region of predissociation in the formaldehyde spectrum. For other cases the available data are insufficient to establish it. As the chief product is always $R'R''$, it is concluded that the primary change is best represented by the scheme $R'.CO.R'' = R'R'' + CO$; $R'R'$ and $R''R''$ are, when formed, only very secondary products. In the *Discussion* on this paper, **W. Frankenburger** considers that the results prove that, in the photochemical decomposition of carbonyl compounds, both the atoms or radicals attached to the CO group are affected practically simultaneously, it being hence much more probable that they will combine with one another than with atoms or radicals from a different molecule. Results of experiments on the formation of carbonyl compounds from H atoms and CO support this view.

PART II. PHOTOCHEMICAL KINETICS IN GASEOUS SYSTEMS.

"Introductory Address," by **M. Bodenstein.** The kinetics of photochemical processes consist of (1) the primary act which is immediately concerned with the absorption of a quantum of light, and (2) the succeeding reactions which the products of (1) undergo. The methods of calculation involving the laws governing the reactions (2), which are merely dark reactions, are briefly considered. An assumption is first required as to the individual reactions making up the whole process. Such assumption is now greatly facilitated by spectroscopic investigation of the primary process, the products of which (excited molecules, atoms or radicals) are mostly unstable and have a very short life before undergoing further changes. Thus a stationary state, in which the formation of the intermediate substances is as great as their consumption, may be assumed; its life is short in relation to the whole duration of the reaction and an appreciable time must elapse before it is established. As many equations as there are unknown concentrations of intermediate substances may be written and the whole system of equations resolved. These considerations are illustrated by means of Nernst's atom chain for the hydrogen-chlorine reaction.

"Chlorknallgas," by **M. Bodenstein.** The assumption as yet most successful in interpreting the observed facts relating to the photochemical union of hydrogen and chlorine is that of the atom chain. If it is realised that the chain may be broken by various reactions, a number of velocity laws are derivable which agree with those determined experimentally. The individual steps of this chain are: (1) $Cl_2 + E = 2Cl$; (2) $Cl + H_2 = HCl + H$; (3) $H + Cl_2 = HCl + Cl$; (4) $H + O_2 = \ldots$; (5) $Cl + O_2 = \ldots$; (6) $Cl + X = Y$ or $Cl \rightarrow \text{walls} = \frac{1}{2}Cl_2$. The assumption of the atom chain gives a good interpretation of a large number of the observed facts, and allows of quantitative estimation of the constants of the single reactions, but it does not explain either the necessity of a very small amount of water-vapour for the combination of H_2 and Cl_2 to occur or the remarkable diminution in quantum yield on changing from visible to ultra-violet light. Difficulty is also presented by the action of inhibitors which, even in the lowest concentrations, prevent the combination, and thus result in the induction period. It is, however, possible to devise a chain mechanism which uses chlorine atoms only for starting the chains and so furnishes an explanation of the *rôle* of steam in the manner suggested by Franck and Rabinowitsch, and is, moreover, in agreement with the observed velocity laws. In the *Discussion* on these two papers, various objections to Bodenstein's suggested mechanism are advanced, and **A. Berthoud** points out that the variations of the velocity of this reaction with the luminous intensity and with the concentrations of Cl, H and O are very complex, and that the use of a number of formulæ, each valid in a limited sphere, is necessary. The fact that, when the pressure of H is small compared with that of Cl, the velocity of this photosynthesis is expressed by $d[ClH] : dt = k[Cl_2][H_2]^{\frac{1}{2}}$, is often overlooked. A series of reactions which explain this equation, and are in agreement with the experimental facts, is given.

"Reaction between H_2 and O_2 under the Influence of Photochemically-Produced H-Atoms and the Relationship of its Mechanism to that of the Burning of Detonating Gas at High Temperatures," by **W. Frankenburger** and **H. Klinkhardt.** Results are given which show that, in hydrogen-oxygen mixtures at room-temperature, photochemically-produced H atoms induce secondary reactions in the course of which about one H_2O_2 mol. and $2H_2O$ mols. are formed per quantum 2537 Å. absorbed. Using the most reliable values for the heat effects accompanying the various reactions involved, Marshall's scheme of a chain producing H_2O_2 is shown to be improbable. At temperatures of about 400°, where the process takes place explosively, it is a chain reaction for which Haber has given the scheme: (1) $H + O_2 + H_2 \rightarrow H_2O + OH + 102$ cal. and (2) $OH + H_2 \rightarrow H_2O + H + 11$ cal. The reaction (3) $2OH + M \rightarrow H_2O_2 + M + 19$ cal. is also possible. Compared with (3), the process (2) is of

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19

little importance at room-temperature, but at about 400° it appears appreciable. The quantum relations of these reactions are considered. In the *Discussion* on this paper, **G. R. Gedye** cites results of work on the hydrogen-oxygen reaction due to gaseous ions which confirm Frankenburger's conclusions.

" Photochemical Union of Hydrogen and Chlorine at Low Pressures," by **J. B. Bateman** and **H. C. Craggs.** Investigation of this reaction at low constant Cl_2 pressures with the help of the Pirani gauge shows that reaction occurs at Cl_2 pressures below 0·2 mm. and at H_2 pressures at least down to 0·04 mm. This result agrees with Marshall's work, but is directly opposed to that of Trifonoff.

" Photosensitised Decomposition of Nitrogen Trichloride and the Induction Period of the Hydrogen-Chlorine Reaction," by **J. G. A. Griffiths** and **R. G. W. Norrish.** When a large excess of Cl_2 is added rapidly to NH_3, NH_4Cl and, if the pressure of the NH_3 is not too high, NCl_3 are formed. If the NH_4Cl is allowed to settle and the residual Cl_2 is added to H_2 in a separate vessel, the mixture is subject to an induction period if NCl_3 was formed. The gradual increase of pressure during the induction period has been traced to photochemical decomposition of the NCl_3 by the Cl_2, and it is now found that exactly similar increases of pressure occur when the H_2 is omitted from the mixture and that the rate of reaction is always proportional to the quantity of light absorbed by the Cl_2. The quantum efficiency (γ) of the decomposition of the NCl_3 depends on the Cl_2 pressure (mm.) thus: $\gamma = 1/kP_{Cl_2} + 2{\cdot}5$, where $1/k$ is the slope of the curve and 2·5 the intercept on the γ axis. The course of the reaction may be described theoretically on the basis of reaction chains starting from Cl atoms formed by the light in the gas phase and ending through some ternary collision in which NCl_3 and a third body take part. Two schemes for the chain mechanism are suggested, and the bearing of the results on the induction period of the H-Cl reaction is discussed. In the *Discussion* on this paper, sudden increases of pressure analogous to that described are cited by **Bodenstein** and by **Allmand.**

" Photosensitised Formation of Hydrogen Peroxide in the System Hydrogen-Oxygen-Chlorine," by **R. G. W. Norrish.** Reasons are given for supposing that the inhibitory action of oxygen in the photochemical reaction between H_2 and Cl_2 is due solely to reaction of the O_2 molecules with the H atoms of the chains, with formation of free hydroxyl radicals, which should combine at room-temperature. This hypothesis is supported by the production of H_2O_2 in appreciable quantities when mixtures of H_2, Cl_2 and O_2 at atmospheric pressure are irradiated in glass apparatus by a mercury lamp.

" Photochemistry of Mixtures of Chlorine, Oxygen and Carbon Monoxide," by **G. K. Rollefson.** An experimental test of the mechanism for the photochemical formation of phosgene proposed by Lenher and Rollefson is described and results are given which favour this mechanism. Reasons are given for considering that the molecule COCl involved in the mechanism cannot be in equilibrium with CO and Cl atoms. In the *Discussion* on this paper, objections to the views expressed are raised by **Bodenstein** and answered by Rollefson.

" Mechanism of the Photochemical Oxidation of Gaseous Alkyl Halides," by **J. R. Bates** and **R. Spence.** A kinetic study of the photochemical oxidation of methyl iodide shows that the effects of altering the light intensity, concentration of reactants and temperature are adequately explainable by a kinetic formula deduced from a mechanism proposed. The quantum yield and the products of the reaction also agree with the theory.

" Comparison of the Efficiency of Photochemical Reactions and Similar Reactions produced by Gaseous Ions," by **G. R. Gedye**. Lind and others showed recently that, in several chain reactions, the yield per quantum is nearly equal to the yield per ion-pair over a wide range of conditions. In the decomposition of NH_3, a reaction not associated with a chain mechanism, the quantum efficiency is rather below one-half of the ion-pair efficiency. Evidence supports the view that NH_3 first dissociates into NH and 2H or H_2, and that hydrazine is formed from NH and NH_3; the latter is probably highly exothermic and should proceed largely on the vessel surface or on dust particles. The reaction $4N_2O = 2NO + O_2 + 3N_2$ proceeds with the quantum efficiency 3·9 (Macdonald, 1928) and, under the action of kathode rays, the same course is followed, but the available data are insufficient to indicate the probable mechanism. For the formation of ozone, the agreement of the quantum (3 for 2070 Å.) and ion-pair efficiencies (1·5–2·6) indicates a similar mechanism—after the primary activation—in the two cases, but for the reverse reaction these two efficiencies are widely different. The value 2 or 3 from the ion-pair efficiency in ozone formation indicates that decomposition involves a chain of some length; in the photochemical decomposition, however, the quantum efficiency is about 2, but under some conditions a chain may here be initiated.

" Phototropic and Photochemical Changes of some Camphor Derivatives in Solution," by **B. K. Singh** and **B. Bhaduri**. α-Naphthylaminocamphor shows the phototropic effect in various organic solvents with 2 or 3 halogens attached to the same C atom, but not in others, photochemical oxidation also occurring. The solvent is assumed to take part in these chemical changes.

PART III. PHOTOCHEMICAL CHANGES IN LIQUID AND SOLID SYSTEMS.

" Introductory Paper: Remarks on Simple Photochemical Phenomena," by **A. Berthoud**. The extents to which the velocity of a photochemical reaction depends on the luminous intensity and on the concentrations of the reactants do not follow general and precise laws. Thus, the proportionality between quantity of matter transformed and quantity of light absorbed, required by the Grotthus-Draper law, is not invariably observed. In general the following laws are obeyed: (1) The number of molecules rendered chemically active by monochromatic light which gives rise to a photochemical reaction is equal to the number of quanta absorbed. (2) The secondary chemical reactions not directly influenced by light follow the law of mass action. (3) The latter applies also to the spontaneous deactivation of molecules, *i.e.*, the velocity of deactivation is proportional to the number of active molecules existing at any moment. Discussion of the evidence indicates that, in most photochemical reactions the period of the active state is quite definitely independent of the concentration of the sensitive substance, and that, if the excited molecules of fluorescent bodies are deactivated by molecular induction, those of non-fluorescent bodies, as a rule, are not. On this basis, an outline is given of a scheme for the mechanism of photochemical reactions, this following logically from Perrin's ideas on molecular induction.

" Photochemical Temperature Effect," by **K. W. Young** and **D. W. G.**

Style. Possible sources of the influence of temperature—especially for photochemical reactions in solutions—capable of giving rise to temperature coefficients which are functions of concentration, wave-length or temperature in a manner different from that expected from the Arrhenius relation, are considered. The data available for various reactions show that the photochemical temperature coefficient is capable of giving valuable information concerning the mechanism of the reaction and the state of dissolved molecules. The dependence of the coefficient on concentration, temperature and wave-length, and its relation to the quantum yield must be studied with monochromatic light.

"Acceleration of the Electrodeposition of Hydrogen and Oxygen by Light of Short Wave-Length," by **F. P. Bowden.** The experimental results given show that the electrodeposition of H_2 and O_2 from acid solution is markedly accelerated by ultra-violet light, the effect increasing as the wave-length of the light diminishes. Ways may be suggested in which predischarged hydrogen dipoles can exist at the electrode, but it is difficult to decide the question from the kinetics and the quantities involved. From study of this light effect it should, however, be possible to ascertain whether the electron emission, resulting in the ultimate formation of a neutral molecule, occurs between $\overset{-}{M} - \overset{+}{H}$ or between $H - \overset{+}{H}$. In the former case the magnitude of the light effect and the threshold frequency should be dependent on, and in the latter case independent of, the nature of the kathode metal.

"Photochemical Decomposition of Chlorine Dioxide in Carbon Tetrachloride," by **Y. Nagai** and **C. F. Goodeve.** The experimental technique for the measurement of the quantum efficiency of a photochemical reaction in solution is described, including a simple but accurate method for measuring thermopile e.m.f. The quantum efficiency of the photochemical decomposition of ClO_2 is found to be $2{\cdot}0 \pm 0{\cdot}2$ mols. per quantum for violet light over a range of concentrations. The following mechanism is supported by thermal and spectroscopic data: $ClO_2 + h\nu \rightarrow ClO_2^{\bullet}$; $ClO_2^{\bullet}(+ CCl_4) \rightarrow Cl + O_2(+ CCl_4)$; $Cl + ClO_2 \pm Cl_2 + O_2$. The possibility of chains is discussed and discarded. In the *Discussion* on this paper, **R. Mecke** presented a diagram for turning energy amounts into the four different energy units commonly used in photochemical work.

"Photochemical Reaction between Iodine and Potassium Oxalate in Aqueous Solution," by **A. J. Allmand** and **K. W. Young.** Experiments on the effects of intensity, temperature and frequency on the reaction between $K_2C_2O_4$ and I_2 in monochromatic light confirm the results of previous workers, the velocity being in every case proportional to the square root of the intensity. The temperature coefficient rises rapidly for shorter wave-lengths with unstirred solutions, this behaviour largely disappearing on stirring. The quantum efficiency is found, by one method of comparison, to increase with increase of wave-length, and by another, to pass through a maximum in the green. Explanations of certain anomalies are advanced, and an attempt is made to deduce a mechanism which, with appropriate modifications, will explain consistently the various known aqueous iodine photochemical oxidations.

"Comparative Study of the Photographic Process in Different Experimental Conditions," by **J. Eggert.** The magnitude of the primary effect in the photographic process, measured by the number of Ag atoms formed per quantum of radiation, increases with the size of the quantum of energy, and the value of the secondary photographic effect, measured by the number of developed AgBr grains, increases similarly; this conclusion is indicated also by the course of the density curve. The desensitisability of the emulsion decreases in the order: light, X-rays, α-rays. The temperature prevailing for the irradiation is without influence on the photographic effect in the case of α-rays, has little influence for X-rays, whilst for light a marked dependence is observed. Special features are noted when such comparisons are made for endothermic silver salts, such as AgN_3, Ag_2C_2 and $Ag_2C_2O_4$.

"Latent Photographic Image: New Methods of Investigation and Results," by **F. Weigert.** The phenomena of induced photodichroism [see Abstract **3313** (**1929**)] are studied in a number of cases important to the knowledge of the latent image.

"Sensitisations of the First and Second Types," by **F. Weigert.** The possibility of differentiating between two characteristic types of sensitisations is indicated. In the first type the sensitiser is present in only very small amounts, and works as a photocatalyst for a large number of reacting molecules, the photochemical efficiency being very great, and γ is much greater than 1. Examples are the colour sensitisers of the photographic emulsions, Hg atoms in the experiments of Caro and Franck, Taylor, Marshall, etc.; the sensitising effect commonly passes through an optimum and then decreases with increasing concentration. Sensitisation of the second type, comprising those by chlorine, etc., require a large excess of the sensitiser. Acetone is a sensitiser of this type, as is shown by the results of examining the photochemical transformation of *o*-nitrobenzaldehyde into *o*-nitrosobenzoic acid.

PART IV. PHOTOSYNTHESIS.

"Introductory Address," by **E. C. C. Baly.** The preparation of catalysts for the synthesis of compounds of the nature of carbohydrates by the action of visible light on CO_2 solution is described. With various ferric oxide mixtures supported on kieselguhr, maxima and minima of photosynthesis occur at the maxima and minima of surface potential, but the yields are only very small, owing to the difficulty of treating the kieselguhr so as to prevent the liberation of alkali.

"Application of the Photochemical Equivalent Law to Vital Processes," by **O. Warburg.** If, in a photochemical process, the absorbed radiant energy Q is measured, the number of absorbing molecules $Q/h\nu$ is obtained according to the quantum theory. By setting the number of reacting molecules equal to that of absorbing molecules (Einstein), the number of photochemical primary processes is obtained. This principle is applied to: (1) Assimilation of CO_2 in green cells. This takes place by combination of four elementary reactions, *i.e.*, in four stages. The percentage energy efficiency is **65** for wave-length **660**, **57** for **578**, and **43** for **436** $\mu\mu$. (2) Chemical constitution of the respiratory ferment. This catalyst behaves like an iron carbonyl compound, giving off CO on exposure to light.

"Photosynthesis in Tropical Sunlight," by **N. R. Dhar, G. Rao** and **A. Ram.** Formaldehyde may be obtained from CO_2 and H_2O in presence of various inorganic and organic photocatalysts and sunlight, traces of glucose being also formed in some cases. Polymerisation of formaldehyde to reducing sugars has been effected in presence of photocatalysts like ferric chloride, nickel carbonate and chlorophyll. A few cases of synthesis of complex nitrogenous compounds are also reported and a new hypothesis for explaining the mechanism of photosynthesis is advanced.

"Measurement of Ultra-Violet Radiation, especially of the Physiologically Active Ultra-Violet (which produces Erythema) by Means of the Photochemical Formation of Triphenylmethane Dyestuffs from the Leuco Compounds," by **E. Weyde** and **W. Frankenburger**. The photochemical rearrangement of the leuco compounds of crystal violet may be used for the determination of ultra-violet radiation for two different purposes: (1) For a laboratory method, the pure alcoholic leuco cyanide is very suitable. The amount of dyestuff photochemically formed is, up to a certain degree of conversion, proportional to the intensity of the radiation to be measured. For wave-lengths 2537 and 3130 Å. the quantum efficiency is 1. (2) For the doctor, meteorologist, etc., the leuco sulphite solution, with an addition which reverses the dyestuff formation, is suitable for measuring the physiologically active ultra-violet. T. H. P.

259. Significance of Oxidation-Reduction Potentials of Dyestuffs for Photographic and Photochemical Systems. A. Steigmann. *Zeits. f. wiss. Phot.* 30. *pp.* 69–76, *Aug.*, 1931.—The veiling of photographic emulsions by coupled dyestuffs was shown to depend on the oxidation-reduction potential of the dyestuff, in the case of certain alkaline developers. The more positive the potential, the easier the starting of the veiling (*Verschleierung*). The action of the dyestuffs is not direct, but is catalytic on the reducing agent. In an illuminated system, such as glutin-methylene blue, the light causes the light absorbing dyestuff to assume a positive potential, in such a way that the reducing agent assumes a negative potential. In consequence the oxidation-reduction potential difference between the electron giver and the electron acceptor of the system is increased. F. J. B.

260. Photochemical Oxidation of Sulphur. R. Dubrisay and R. Pallu. *Comptes Rendus*, 193. *pp.* 339–340, *Aug.* 17, 1931.—On exposing flowers of sulphur to ultra-violet light in a quartz vessel containing air at 35–40°, without and with moisture, for 16 and 44 days respectively, the first product in both cases is probably pentathionic acid, which then decomposes with formation of sulphuric acid, hydrogen sulphide, sulphur and sulphur dioxide, the last in presence of oxygen and ultra-violet light forming more sulphuric acid. C. A. S.

261. Synthesis of Ammonia in the Low-Voltage Arc. A. K. Brewer and R. R. Miller. *Am. Chem. Soc., J.* 53. *pp.* 2968–2978, *Aug.*, 1931.—The rate of synthesis of NH_3 in the low-voltage arc is proportional to the current flowing through the discharge, is independent of the pressure of ammonia over a wide range and is accelerated by excess N_2 and retarded by excess H_2. The maximum rate of synthesis is obtained in gas mixtures containing 83 % N_2. Synthesis does not take place if the voltage of the arc is below the ionisation potential of N_2. Between 17 and 23 volts the rate of synthesis increases rapidly, while above 23 volts the increase is linear. It is suggested that N_2^+ and N^+ ions are the reactive species which bring about the synthesis. The M/N ratio would appear to be about two for the former and one for the latter. F. J. W.

262. Propagation of Combustion Along the Surface of Inflammable Liquid. Part I. T. Kinbara. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers Nos.* 312–315. *pp.* 91–108, *Aug.*, 1931. *In English.*—For sheets of paper or asbestos paper soaked with ethyl alcohol, a flame kindled at the centre of a circular plane gave discordant results. Kindling at the surface of combustible liquid contained in a basin gave comparatively good results. The density of the vapour influences the propagation of combustion. The effect of impurities is also investigated. It is shown that the relation of velocity and temperature is similar to that for the pure material. The temperature at which the velocity becomes a maximum increases as the concentration of the combustible decreases. The maximum velocity increases with the concentration of the combustible. The various relationships for a mixture of two liquids is also determined, as for instance, for methyl alcohol and ethyl alcohol, ethyl alcohol and benzene. J. K.

263. Kinetics of Gas Reactions at Constant Pressure. A. F. Benton. *Am. Chem. Soc., J.* **53.** *pp.* **2984–2988,** *Aug.*, **1931.**—The object of this paper is to point out that kinetic equations for reactions at constant volume are not necessarily applicable to reactions at constant pressure, and to indicate how the latter are to be correctly treated. Homogeneous unimolecular gas reactions; homogeneous unimolecular reactions in flow systems; first order catalysed reactions; and bimolecular reactions are dealt with. H. H. Ho.

264. Kinetics of Oxidation of Cyanogen. H. J. Hadow and C. N. Hinshelwood. *Roy. Soc., Proc.* **132.** *pp.* **375–387,** *Aug.* **1, 1931.**—At 700° C. CN reacts with O_2 to give N_2 and a mixture of CO and CO_2. In silicon vessels the oxidation takes place principally on the surface at a rate approximately proportional to $[C_2N_2]^{\frac{1}{2}}[O_2]^{\frac{1}{2}}$. No detectable quantity of oxides of nitrogen is formed, nor do traces of these oxides influence the reaction. Further oxidation of the CO formed is inhibited until all the CN is used up, when an explosion takes place. CO_2 is, however, formed during the entire course of the reaction by a special mechanism. It is suggested that surface oxidation of the CN yields activated CO, which either escapes from the surface and can be deactivated by CN or reacts with O_2 before deactivation. Water vapour facilitates the explosion of the CO, but not the initial oxidation of the CN. When O_2 is added to the reaction vessel before the CN, there is a delay in the establishment of adsorption equilibrium. When the initial pressure of CN exceeds a certain limit, explosion occurs; the limit depends on the state of the surface but is higher in vessels of small diameter, and may depend on particular adsorption relations. H. H. Ho.

265. Velocity Constants for Thermal Dissociation of Ethane and Propane. L. F. Marek and W. B. McCluer. *Indust. and Engin. Chem.* **23.** *pp.* **878–879;** *Disc.*, **879–881,** *Aug.*, **1931.**—The velocity constants of the thermal decomposition of ethane and propane were determined by passing the purified and dried gases through a preheater and then through a copper reactor which was heated to a carefully controlled temperature. The extent of the cracking was determined by the difference in composition of samples from the preheater and the reaction coil. The values of the velocity constant for the thermal dissociation of ethane and propane and the hydrogenation of ethylene over the temperature range 600°–700° C. are given by the respective equations: $\log k = 15{\cdot}12 - 15{,}970/T$, $\log k = 13{\cdot}44 - 13{,}500/T$, $\log k = 8{\cdot}79 - 9140/T$. F. J. B.

266. Dependence of Reaction Velocity on Surface and Agitation. A. W. Hixson and J. H. Crowell. *Indust. and Engin. Chem.* 23. *pp.* 923–931, *Aug.*, 1931.—The subject of agitation is discussed with a view to the establishment of a basis which might serve for a quantitative comparison of different agitations. Since the velocity of a heterogeneous reaction is generally quite sensitive to the effect of agitation, its use in this connection is considered. With such a reaction the surface effects are, however, equally important and have to be studied as part of the original problem. A detailed analysis of the idea of agitation is made and its resolution into its final fundamental elements attempted. A new law, termed the cube-root law, is derived from theoretical considerations, the velocity of dissolution of a solid in a liquid being expressed as a function of the surface of the solid and of the concentration of the solution. The paper is scarcely suitable for detailed abstraction. T. H. P.

267. Reaction Rate in the System Solid-Solid-Gas. R. S. Bradley. *Phil. Mag.* 12. *pp.* 290–296, *Aug.*, 1931. *Supplement.*—The derivation of the rate at which molecules leave an interface, based on Frenkel's [see Abstract 2844 (1924)] assumption of the phase volume of a molecule oscillating on a surface of given area, is criticised adversely, and a more direct treatment proposed, especially as the direct and reverse rates are quite independent. The paper is entirely mathematical, and the reaction rates observed by Garner and Tanner [*Chem. Soc. J.*, p. 47, 1930] for the decomposition $CuSO_4, 5H_2O \rightarrow CuSO_4 . H_2O + 4H_2O$ are utilised in exemplification of the revised formulæ put forward. H. H. Ho.

268. Velocity of Unimolecular Reaction. A. Ganguli. *Phil. Mag.* 12. *pp.* 583–589, *Aug.*, 1931.—A unimolecular reaction is regarded as being similar to a process of thermal ionisation. Assuming the radiation hypothesis of Perrin and using the above analogy, the equation for the rate of a unimolecular reaction has been calculated. F. J. W.

269. Mechanism of Chemical Change. Part II. Catalysis of the Mutarotation of Beryllium Benzoylcamphor. Part III. Mutarotation of Aluminium Benzoylcamphor. T. M. Lowry and R. C. Traill. *Roy. Soc., Proc.* 132. *pp.* 398–427, *Aug.* 1, 1931.—These papers record a continuation of previous work [see Abstract 2668 (1928)]. The mutarotation of beryllium benzoylcamphor is found to be very slow, both in carbon tetrachloride and in chloroform, and is not spontaneous but depends on the presence of a catalyst, *e.g.*, pyridine, alcohol and *p*-cresol. The velocity coefficient is proportional to the concentration of pyridine, which therefore gives a constant "catalytic coefficient," but these coefficients in the case of alcohol and *p*-cresol decrease with increase of concentration, due probably to the formation of a relatively stable complex of solute and catalyst; this is shown to correspond with the requirements of the law of mass action. The crystalline compound of beryllium benzoylcamphor with chloroform is formulated as a "racemate," with four molecules of chloroform of crystallisation. The displacement of equilibrium on passing from carbon tetrachloride to chloroform as solvent is attributed to the selective formation of a chloroform-compound by α- and β-forms of the solution. The changes due to *p*-cresol are in accordance with the law of mass action. The mechanism of the chemical change which gives rise to the mutarotation is discussed. The mutarotation of aluminium benzoylcamphor is very fast in carbon tetrachloride and proceeds even more rapidly in chloroform, attaining the maximum quickly and then followed by a slow fall to a steady value. The form of the mutarotation curves in carbon tetrachloride and in alcohol can be expressed by the algebraic sum of two exponential terms of opposite sign: $[\alpha]_t = Ae^{-m_1 t} + Be^{-m_2 t} + C$, an equation which serves for solutions in carbon tetrachloride when catalysed by pyridine but not by alcohol (complex compound formation). H. H. Ho.

270. Dehydration of Copper Sulphate Pentahydrate. J. Hume and J. Colvin. *Roy. Soc., Proc.* 132. *pp.* 548–560, *Aug.* 1, 1931.—The rate of dehydration of $CuSO_4, 5H_2O$ has been measured at 20° C., *in vacuo*, using uniform particles of known size. The results have been analysed by a method which enables the linear rate of propagation of the reaction $CuSO_4 . 5H_2O \xrightarrow{-2H_2O} CuSO_4 . 3H_2O$ through the pentahydrate to be determined, and suggest that the rate of loss of four molecules of water is controlled by the linear rate of advance of the interface between the solid phases. The complete reaction possibly occurs in two successive stages, the first stage, as above, being succeeded by subsequent dehydration to $CuSO_4 . H_2O$. The effective interface is that between penta- and trihydrate. Evidence is obtained that a solid hydrate, on decomposition, gives rise to a layer of material of almost molecular size. Whether this layer aggregates or decomposes depends on surrounding conditions. Aggregation and slow nucleation account for the persistence in mixtures of hydrates of a hydrate which is metastable under the vapour tension conditions of the environment. J. S. G. T.

271. Absorption of Metastable and Ionised Nitrogen by Magnesium. P. I. Lukirsky and S. W. Ptizyn. *Zeits. f. Physik*, 71. 5–6. *pp.* 339–349, *Aug* 29, 1931.—If magnesium is vaporised in an atmosphere of nitrogen and in a vessel cooled in liquid air, considerable quantities of nitrogen are absorbed, provided the rate of vaporisation is great enough. Such nitrogen can be recovered unchanged if the temperature of the condensed layer is raised to 100° C. If molecular nitrogen is ionised by collision, a rapid absorption of nitrogen occurs to form magnesium nitride. The rate of absorption of nitrogen is proportional to the positive-ion current from the magnesium which serves as an anode. The absorption and positive-ion current from the magnesium begin when nitrogen collides with 8-volt electrons, and therefore the absorption is due to the reaction of metastable nitrogen molecules with magnesium. F. J. W.

272. Wave-Mechanics Significance of Chemical Valency. A. Sommerfeld and K. Bechert. *V.D.I.* 75. *pp.* 1019–1020, *Aug.* 8, 1931. —The mutual action of two similar atoms corresponds, from the wave-mechanics point of view, with the coupling of two equal pendulums. There are two forms of vibration, the symmetrical form allowing of chemical combination. The *Electronen-drall* hypothesis and Pauli's principle limit considerably the possibilities of combination. These principles are illustrated for the noble gases, alkalies, alkaline earths, and the nitrogen, oxygen and carbon series. T. H. P.

273. Unsaturated Type Standard Cells. Y. Ishibashi and T. Ishizaki. *Electrot. Laborat. Tokyo, Japan, Researches, No.* 314. [18 *pp.*], *March*, 1931.—Deals with neutral and acid cells. According to the authors' experiments, the most appropriate cells are of the cadmium sulphate concentration of 43·0 %, the acidity of electrolytes being 0·05 *N*. The e.m.f. of these cells at 20° C. is 1·01840 volts; and the temperature coefficient is nearly zero. AUTHORS.

274. Hysteresis in the Weston Standard Cell. W. C. Vosburgh and K. L. Elmore. *Am. Chem. Soc., J.* 53. *pp.* 2819–2831, *Aug.*, 1931.—A large number of Weston standard cells were made from carefully selected and purified materials. The cells were of the usual H-form. The e.m.f. was measured at intervals extending over months and the hysteresis determined. It was found that gelatin and materials extracted from cork increased the hysteresis in acid Weston cells considerably. Cells with no added acid or basic material showed more hysteresis than cells containing basic cadmium sulphate. The e.m.f. of cells to which basic cadmium sulphate had been added were less variable over a period of several months and more reproducible than those of similar cells to which basic or acid material was added. Basic cells showed a lower e.m.f. than the normal after the first month. The e.m.f.s of cells containing oxygen decreased less than corresponding cells containing nitrogen. F. J. B.

275. Glass Electrode. H. Kahler and F. DeEds. *Am. Chem. Soc., J.* 53. *pp.* 2998–3012, *Aug.*, 1931.—The specific resistances of several glasses have been determined as well as decrease of resistance with rise of temperature. It is shown that, without waiting for the system to come to complete equilibrium, glasses give deviations from the theoretical calibration curve (volts against pH) which are roughly proportional to the thickness on the side of smaller fluid immersion, whereas on the larger side the calibration is close to the theoretical. This effect is found to be caused by the formation of a hygroscopic deviation film on the glass surface above the water-line, and it is suggested that the potential measured is the value of the spurious film potential and the true value of the immersed glass connected in parallel. By changing the character of the film above the line, the values given by the electrode could be changed. By suppressing the film through coats of dielectric paints, the deleterious effect could be practically eliminated as long as no water penetrated under the coating. Potentials were measured through various thin semi-conducting coatings on glass bulbs. The potential on the coated side of the glass shows only a slight dependence on the pH of the solution and large salt effects. The opposite side of the glass wall, however, shows its usual calibration. The change in salt effects for a pH range from 3·97 to 12·55 was determined. Specific salt effects over the secondary hydrogen ion change only become important in the extreme range of pH values. H. H. Ho.

276. Temperature Measurements at Active Electrodes. Part V. B. Bružs. *Zeits.f.phys.Chem.* 155. *Abt. A.* 5–6. *pp.* 392–402, *Aug.*, 1931.—This paper continues a previous investigation [see Abstract 2881 (1931)] and indicates that the Q* corrections proposed by Lange and Miščenko for the relationship of the Peltier effect and the latent heats of the electrode processes may only be made *via* classical thermodynamics at concentration polarisations. A thermoelectric effect, apparently not yet described, is explained by the influence of concentration polarisation on the Peltier effect. In the case of cadmium amalgam electrodes in cadmium sulphate solution, various causes of disturbances in measurements of the Peltier effects are discussed and the results obtained are compared with measure-

ments of thermoelements. In the case of the $Hg|Hg_2SO_4|SO_4''$ electrode, the possibility is shown of calculating the absolute partial specific heats.
H. H. Ho.

277. Becquerel Effect. Part IV. I. Lifschitz and M. Reggiani. *Zeits. f. phys. Chem.* 155. *Abt. A.* 5–6. *pp.* 431–450, *Aug.*, 1931.—The Becquerel effect of the second kind, *viz.*, cells in which the part sensitive to light is the electrolyte, was investigated, and the use of electrodes of metals other than platinum was tried. Electrodes of Nb and Ta were used, and further electrodes of Mo and W in the form of wire were utilised. The electrolytes were normal solutions of sulphuric and hydrochloric acids, and normal solutions of sulphate, chloride and nitrate of potassium, sodium hydrate and strontium nitrate. The results showed that a number of electrode materials were available which showed no Becquerel effect, and with electrodes of tungsten-bronze no Becquerel effect of the second kind was evident. Passive metals were considered as possible electrodes, and could be measured in a number of electrolytes, and might behave in a similar manner to the noble metal electrodes. The valve electrode behaviour of Nb, Ta, Fe, Zn and Cd was investigated and it was found that the valve action was greatly reduced, or even stopped, by illumination from a quartz lamp. [For Part III see Abstract 2703 (1330).] F. J. B.

278. Conductivities of Tetraethylammonium and Ammonium Salts in Methyl Alcohol. Augusta Unmack, E. Bullock, D. M. Murray-Rust and H. Hartley. *Roy. Soc., Proc.* 132. *pp.* 427–441, *Aug.* 1, 1931.—The electrical conductivity in methyl alcohol of certain tetraethylammonium and ammonium salts has been measured at 250° C. over a range of concentration from 0·0001 to 0·002 *N*. The mobility of the NEt_4^+ ion is 62·1 and of the ammonium ion 58·1. With one exception, the salts conform to the square root relation $\Lambda_c = \Lambda_0 - x\sqrt{c}$ over the range of concentration studied, and the observed values of the coefficient x have been compared with those calculated from the theory of Debye, Hückel and Onsager. The ammonium salts are in better agreement with theory than the tetraethylammonium salts, most of which show considerable deviations. H. H. Ho.

279. Effect of Pressure on Electrical Conductivity of Solutions of Sodium Chloride and Other Electrolytes. L. H. Adams and R. E. Hall. *J. Phys. Chem.* 35. *pp.* 2145–2163, *Aug.*, 1931.—The electrical conductivities of solutions, dilute and concentrated, of NaCl, of dilute solutions of K_2SO_4, and one KCl solution, were determined at pressures somewhat above 4000 bars (metric atmospheres). The conductivity of NaCl at high pressures was found to pass through a maximum, in the same way as other salts at atmospheric pressure. The results were expressed in terms of the resistance ratio, R/R_0, where R was the resistance of the cell at a given pressure and concentration, and R_0 the resistance at atmospheric pressure. The temperature coefficient of R/R_0 for concentrated solutions of NaCl was positive, but was negative for dilute solutions. The general behaviour of conductivity of solutions under pressure is discussed and the importance of the viscosity of the solution is emphasised. F. J. B.

280. Influence of Higher Terms of the Debye-Hückel Theory in the Case of Unsymmetric Valence-Type Electrolytes. V. K. la Mer, T. H. Gronwall and L. J. Greiff. *J. Phys. Chem.* 35. *pp.* 2245–2288, *Aug.*, 1931.—Numerical evaluation of the second and third order terms in Gronwall's solution of the Poisson-Boltzmann equation [see Abstract 2871 (1928)] is completed from $x = 0$ to $x = 0 \cdot 4$ in steps of $0 \cdot 1$. Comparison of the appropriate resulting theoretical curves is made with (1) e.m.f. data for salts of types 2, — 1, and 3, — 1; the extension is in better agreement with experiment to concentrations of 0·01M than is the first approximation in that more plausible values for *a* are required, more consistent values of *a* are given, and the E_0 value so calculated, for each experimental determination shows a constancy of the same order of magnitude as the experimental error; (2) freezing-point data for 1, — 2, and 1, — 3 salts, which result in better agreement (to concentrations of 0·01M) of experiment with the extended theory than with the first approximation; (3) the solubility of a difficultly soluble salt in a solvent salt solution in the case of luteocobaltic diamminodinitro-oxalocobaltiate in potassium sulphate solutions; here, too, concordant results are obtained. T. H. P.

281. Electrolysis of Perchlorates in Non-Aqueous Solutions. A. L. Chaney and C. A. Mann. *J. Phys. Chem.* 35. *pp.* 2289–2314, *Aug.*, 1931.—Anhydrous perchlorates of Pb and Cd were prepared by heating the hydrated salts in a vacuum oven. The dihydrates of Co, Cu, Mn, Ni and Zn were prepared from the corresponding hexahydrated perchlorates. The approximate solubility of the metallic perchlorates were determined in furfural and cellosolve (monoethyl ether of ethylene glycol). The conductivities of a series of metallic perchlorates were made in furfural, cellosolve, ethylene glycol and pyridine over a range of concentration from 0·1 *N* to 0·00001 *N*. The electrode potentials of Zn, Cd, Co, Ni, Pb, Cu and Ag were measured in their perchlorate solutions in furfural and cellosolve. The deposition of several of these metals from perchlorate solutions was studied. F. J. B.

282. Accurate Form of Copper Coulombmeter. H. P. Matthews and I. W. Wark. *J. Phys. Chem.* 35. *pp.* 2345–2356, *Aug.*, 1931.—The Marshall copper coulombmeter was found to be satisfactory for currents greater than 10 amperes, but in its original form not sufficiently accurate for currents appreciably less. Certain modifications served to reduce the error for low current densities to less than 0·2 %. The temperature must not exceed 30°, and it is better not to rotate the kathode, although errors due to these causes can be reduced by bubbling hydrogen through the electrolyte. Alcohol additions are in general unnecessary. Large variations in acidity or lengthy periods of electrolysis are without effect. G. E. B.

283. Depolarisation Stream in the Capillary Electrometer. F. O. Koenig. *Zeits. f. phys. Chem.* 156. *Abt. A.* 1. *pp.* 38–40, *Aug.*, 1931. —Continuing a previous discussion [see Abstract 3655 (1931)], it is now shown that the depolarisation stream in a capillary electrometer, using an alkali salt as the foreign electrolyte, is entirely due to positive H ions, which, passing through the mercury-electrolyte limiting layer at the polarised kathode, enter the solution and become H_2 molecules which diffuse throughout the solution. J. E.

284. Formation of Anode Mud in the Electrolysis of Copper Solutions. O. Essin. *Zeits. f. phys. Chem.* 156. *Abt. A.* 1. *pp.* 41–50, *Aug.*, 1931.—The conditions for the formation of the fine powdered copper, produced by the anodic solution of copper anodes in solutions of copper sulphate acidified with sulphuric acid, were examined. The cupro-cupri equilibrium at the electrodes is discussed. It is assumed that as the cuprous and cupric ions are discharged at the kathode, copper is dissolved at the anode by the reversible electrolysis of the equilibrium solution, so that solution takes place proportionally to the relative concentrations of the ions. In the light of this assumption it is shown that the current disturbs the equilibrium between the cuprous and cupric ions in the vicinity of the electrode. The disturbed equilibrium brings about the reaction at the anode: $2Cu' \rightarrow Cu'' + Cu'$, which uses up the excess of cuprous ions and forms the spongy copper. In this way the formation of anode mud is independent of polarisation. F. J. B.

285. Kathodic Passive Phenomena. E. Liebreich. *Zeits. f. phys. Chem.* 156. *Abt. A.* 1. *pp.* 51–76, *Aug.*, 1931.—Experiments were made to determine the kathodic behaviour of zinc. It was found that when zinc was polarised kathodically, in $0 \cdot 1\ N$ sulphuric acid, the metal became passive over a range of current densities. The current density ranged from the transition from the region of the residual current to that part of the current-voltage curve where it commenced to straighten. The commencement of the mechanical passivity of zinc could be obtained from curves, the changes of potential of the kathode, compared with the changes in the transition resistance and the current strength, could be followed as the polarisation increased. Zinc showed a difference from other metals in its behaviour with decreasing polarisation when the passive layer was penetrated and evolution of hydrogen resulted. F. J. B.

286. Electrolytic Dissociation of Transitional Metal Salts. Part I. D. J. G. Ives and H. L. Riley. *Chem. Soc., J. pp.* 1998–2012, *Aug.*, 1931.—The electric conductivity and dissociation constants were determined for zinc malonate, zinc isopropylmalonate, copper malonate, copper methylmalonate, ethyl malonate and propylmalonate. Copper isopropylmalonate, diethylmalonate, dimethylmalonate, di-*n*-propylmalonate and zinc salts of the same acids and nickel malonate. Except for the diethyl and dipropyl compounds the values of the dissociation constants of the various copper salts followed the same order as those recorded for the constants of instability of the corresponding dimalonatocupriate complex ions. The substitution of Me, Et, and Pr caused a small increase, Me_2 a larger increase, and $Pr\beta$ a small decrease in the dissociation constant of the normal salt. F. J. B.

287. Electroendosmosis in Closed Cylindrical Tubes of Large Diameter. B. W. Currie. *Phil. Mag.* 12. *pp.* 429–438, *Aug.*, 1931.—Theoretical and experimental investigation was made of the electroendosmotic flow of a liquid in a closed cylindrical tube. It is shown that the velocity of the liquid has a parabolic distribution across closed cylindrical tubes of large as well as of small diameter. The velocity along the axis is independent of the diameter of the tube. The velocity along the axis of a silica cell is constant and equal to $0 \cdot 69 \times 10^{-4}$ cm./sec./volt/cm. for water having a specific conductivity between $1 \cdot 0$ and $1 \cdot 6 \times 10^{-6}$ ohm^{-1}cm.$^{-1}$ The cataphoretic velocity of a particle depends on its shape. J. J. S.